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in Charles Stakman: President of AAAS, 1949

n Hart, *University of Minnesota*

O PLACE A SCIENTIST in an applied field of biology at the helm of the AAAS might have been considered utter heresy not so many years imes change, however, and today both the aca- nd applied fields of all the sciences are filled road-visioned men dealing with theories, prin- , applications, and the whole gamut of scientific ciences in relation to human progress. The Ivory r is obsolete largely because of the beliefs and ties of such men as E. C. Stakman, who is chief e University of Minnesota's Division of Plant ology and Agricultural Botany and agent in the . Department of Agriculture.

new president of the AAAS, born May 17, , in Algoma, Wisconsin, and educated in Minne- , has the adventurous spirit of the Midwest. Life never a bowl of roses to be admired and enjoyed mere beauty. An education involved struggle, rous discipline, and sacrifice. Keenness of obser- on was to be sharpened by constant practice and nse interest in ordinary and extraordinary phe- ena of everyday living. New ideas were to be ertained and carefully investigated. Intellectual egration of known facts and the ability to think rly were worth many long hours of discussion and ument. The result is a vital, dynamic, stimulating rsonality eager for participation in numerous intel- ual pursuits and tireless in efforts to enable other udents the world over to contribute to human knowl- ge.

takman was graduated from the University of Min- ta in 1906 and was honored by election to Phi Kappa. The M.A. degree was conferred upon in 1910, and the Ph.D. in 1913. The honorary ctor of Natural Sciences was awarded by the Uni- sity of Halle-Wittenberg in 1938. He is a member Sigma Xi, the National Academy of Sciences, the erican Philosophical Society, the American Acad- y of Arts and Sciences, the Washington Academy Arts and Sciences, and L'Académie Royale d'Agri- ure de Suède. He holds honorary membership in Sydney University Agricultural Society and the nadian Phytopathological Society, and was instru- ntal in organizing the Mexican Phytopathological ciety. He has served as president of The American ytopathological Society, as chairman of numerous that society, and as editor-in-chief of *opathology*. He also has been Ameri- *topathologische Zeitschrift* and a member of the editorial committee of *Annual Review of Microbiology*. He is an active and forceful member of the Executive Committee of the National Research Council and the Advisory Committee on Biology and Medicine of the U. S. Atomic Energy Commission. He represents the AAAS on the Cooperative Committee on Science Teaching. Throughout his scientific life Stakman has been associated with the University of Minnesota and the U. S. Department of Agriculture. In 1930, however, he was visiting professor at the University of Halle-Wittenberg, and on numerous occasions he has undertaken special scientific or educational missions while on leave from the University.

The researches of Prof. Stakman and his colleagues have helped to lay foundations for many cooperative enterprises of plant scientists and agriculturalists. He has succeeded in coordinating controlled and precise experimental work in the biological laboratory with extensive and careful observations in Nature's laboratory. His researches on physiologic specialization within species of the rust fungi and on epidemiology of the cereal rust diseases elucidated the pathological principles basic to the synthesis of disease-resistant varieties of cereal crops for the vast grain-growing areas of the Mississippi Valley. His painstaking work on physiologic specialization of numerous fungi has influenced the biologist's concept of a species and has provided a better understanding of the biotypes and racial entities that make up a taxonomic species. Studies on barberries have emphasized the importance of the stem rust's al[illegible] host as a source of inoculum for cereal [illegible] place for the fungus where [illegible] some of which may be far more dangerous [illegible] progenitors. Stakman's researches on [illegible] have opened the way for [illegible] cerning genetics of microorganisms [illegible] lonts (1n) are easily cultured [illegible] physiologic study and [illegible] to provide material for [illegible] various characters. His [illegible] were pioneer work—probably the first [illegible] airplanes were used to [illegible] in the air. From that work have come [illegible] studies on the distribution of [illegible] isms, on the dissemination of plant pathogens [illegible] continental areas, and [illegible] measures [illegible] bat the introduction [illegible] pathogens [illegible]

Professional tra[illegible]

Prof. Stakman. While studying the cereal rusts, he undertook scientific missions to Europe, to Alaska, and throughout the United States and Mexico for the U. S. Department of Agriculture. Inquiry into disease problems of rubber production in Liberia and establishment of a research laboratory for the Firestone Plantations Company in 1930 necessitated travel in West Africa and also a survey of rubber production in the Far East. During World War II, in the interests of national defense in the Western Hemisphere, Stakman joined a Department of Agriculture Commission to study native rubber in South America and the possibilities of increasing *Hevea* rubber production there. In 1941 he was a member of the Rockefeller Foundation's commission to survey agricultural needs in Mexico, and two years later he helped in the implementation of the Foundation's program for agricultural improvement. More recently he has assisted the Foundation in a survey of agricultural problems and status of education and research in the natural sciences in various countries of Central and America. Late in 1948 he became a member o mission of scientists from the National Acad pointed to assist Gen. MacArthur in a survey tific research institutions in Japan.

While Dr. Stakman is known primarily as pathologist and agriculturalist, he also is a r educator. Graduate students and postdocto lows from every continent in the world have st his laboratories and have gained an insight n into the scientific fields of biology and agricult also into the broad cultural life of an America versity and the history and development of the p of the United States. They have found intel consideration and sympathetic understanding of own national or racial cultures and intense inter their present and future problems.

The honor and responsibilities of the Associ presidency for 1949 have been well placed in th entist Elvin Charles Stakman.

Research and the Development of Atomic Energy

Robert F. Bacher, ***Member, U. S. Atomic Energy Commission***

RESEARCH IS THE BACKBONE of the development of atomic energy. While the development of atomic energy also depends upon a host of technological improvements and upon the strength of industrial development and management, the guidance of research is a necessary requirement. Today, the research carried on under the atomic energy project ranges through physics, chemistry, metallurgy, the biological sciences, medicine, and most of the branches of engineering. The shortage of trained scientific and technical personnel, due at least in part to these greatly expanded activities, has prompted the Atomic Energy Commission to establish fellowship programs in the physical sciences and in biology and medicine and to set up technical training programs in radiation effects and the use of radioactive isotopes.

The main work of the U. S. Atomic Energy Commission is carried on in several Divisions: the Division of Production, which includes the production of raw materials from which fissionable materials are made and the production of fissionable materials themselves; the Division of Military Application, which covers the research, development, and production of atomic weapons; two Research Divisions, one for the physical sciences and one for the biological and me sciences; and the Division of Reactor Developm In addition, there are, of course, many support activities which are an important and necessary p of the general administrative organization.

Most of the work in atomic energy is conducted contract with industrial companies, universities, search organizations, and other government age The greater part of it is carried out in installa especially erected for that purpose, although so it is located in installations owned by the variou tractors. The Atomic Energy Commission plan coordinates this work. It is very important, f ample, that work in the production of fissic materials keep abreast of the developments of weapons and vice versa, and that research in r development take account of recent experiences production of fissionable materials in reactors.

Since a large part of the work of the atomic project is carried on in several large in these installations have formed centers [illegible] ment. At Oak Ridge, for example, there is a m ager who is responsible for all of the activities th as well as for several other contracts associated with the Oak Ridge work o Similarly, there are Managers at

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Address delivered at the November 18, 1948, meeting [illegible] the [illegible] Academy of Sciences.

Argonne National Laboratory is located; at Santa Fe, New Mexico, site of the Los Alamos Laboratory; at Richland, Washington, where the Hanford plutonium plant is located; and at New York, for the operation of the Brookhaven National Laboratory and many contracts associated with the procurement and processing of raw materials.

All of the major contracts of the Atomic Energy Commission are administered through one or another of these offices under the guidance of the various Divisions indicated above. Each of these Managers reports to one of the Division Directors in Washington whose responsibility covers most completely the work carried on by his office. These Division Directors report to a General Manager, who is responsible for carrying out Commission policy. Since every field office must carry on work in a large number of areas, a considerable amount of coordination is needed both by that responsible Division Director and by the Manager. It is the Commission's aim to have very close contact between the Planning Division in Washington and those working directly in the field.

The core of the Commission's work is the procurement and processing of raw materials, the production of fissionable materials, and their utilization either in nuclear reactors or in atomic weapons. As is well known, uranium plays a unique role as a raw material in the production of atomic energy. Natural uranium contains a small fraction—1 part in 140—of uranium of mass 235, which possesses the ability to produce nuclear fission with low-energy neutrons. It is this property, sometimes referred to as the property of nuclear inflammability, which allows one to make a nuclear reactor from natural uranium and graphite or from uranium and heavy water. Other materials, including thorium and the more abundant isotope of uranium of mass 238, are able to produce nuclear fission only with higher-energy neutrons and cannot by themselves maintain a nuclear chain reaction.

Since natural uranium has this unique property, it is a highly important element in the development of atomic energy. In the past, very little effort was put into the search for sources of uranium and into its extraction from low-grade ores. Prior to the development of atomic energy, uranium was used mainly for the extraction of radium and, once the radium had been extracted, was of little or no use. Gen. McNaughton, of Canada, once told me that when he became president of the National Research Council of Canada in 1935, one of his first problems was how to utilize the large amounts of uranium from which the radium had been extracted. That little problem seems to have been solved.

Today, our ideas of the amount of uranium available in the world are necessarily fragmentary. The intensive search for uranium has just begun. In the past, only high-grade deposits were mined; now, new information is being sought on how uranium may be extracted from low-grade ores, and at the same time the location and assessment of low-grade ore bodies are being determined. An intensive effort is being made in this direction, and it accounts for one of the major lines of research and development at present.

Tulane Unive

Under the general category of production, uranium ore is processed, purified, and made either into uranium hexafluoride for use in the diffusion plants at Oak Ridge or into uranium metal for insertion in the nuclear reactors at Hanford. Each of the steps in this process has been subject to a great many changes as a result of research and development and, indeed, the production of uranium hexafluoride and the production of uranium metal were, in their earliest stages, research processes.

One of the major aims of the production program is to obtain a purified fissionable material, since this can be used either in a variety of nuclear reactors or for the production of atomic weapons. One method of obtaining fissionable material is to separate uranium 235 from the natural uranium by a gaseous diffusion method which was developed during the war and put into operation in 1945. For this purpose a very large plant was constructed at Oak Ridge. This plant contains miles and miles of piping and many hundreds of pumps. The separation of uranium 235 from uranium 238 is accomplished in a very large number of steps and depends essentially upon the fact that, due to its smaller mass, a molecule of uranium hexafluoride (UF_6) containing uranium 235 has a slightly greater chance of diffusion through a tiny hole than one containing uranium 238. As you may guess, this probability is not much greater, and the operation must be conducted many times in order to achieve any sensible separation of isotopes. That this is a practical method of isotope separation is a tribute to technology and industry. Of course, research has played a tremendous role in the development of the gaseous diffusion method, and today, a great amount of process development is going on which constantly improves the efficiency and reliability of the operations.

Another method of isotope separation which was pursued vigorously during the war is the electromagnetic method. Here the separation of isotopes depends upon the curvature of the paths of ions of different masses in a uniform magnetic field. It is the old principle of the mass spectrograph used on an industrial scale. Today, the plant constructed at Oak Ridge during the war for the separation of uranium isotopes by the electromagnetic method is largely in stand-by condition. Work on new developments is going forward, however, and a small part of the wartime installation is operated to test new improvements. In addition, the research and development work on separation of uranium isotopes by the electromagnetic method is continued with the separation in small amounts of the isotopes of many other elements. Small quantities of these are needed in many cases to sort out the nuclear properties of the various isotopes, since these nuclei are as different one from another as those of ordinary atoms. Some of these separate stable isotopes are important as tracers, but more of that later.

Several other methods of isotope separation were explored during the war, and some of them were actually acted upon and plants constructed. A thermal diffusion plant was operated for a short time at Oak Ridge. Research and development work on the separation of isotopes by a centrifuge method was undertaken, but no plant was ever constructed. New means for the separation of isotopes beyond those already tried or now in active use depend upon fundamental research for their foundation.

The production of fissionable materials in a nuclear reactor is accomplished in a very spectacular way. The whole idea of a nuclear reactor and the operation of a self-sustaining nuclear reaction is, indeed, a revolutionary one. Since the first self-sustaining nuclear reaction was achieved at the Metallurgical Laboratory in Chicago, just about 6 years ago, several reactors for research, development, and production purposes have been constructed. Nuclear reactors were developed during the war solely for the purpose of producing a new element—plutonium—which is a fissionable material and may, therefore, be used as an ingredient for the production of atomic weapons. Plutonium is produced from the excess neutrons which are generated in the fission process. Some of these neutrons produce more fissions in uranium 235; others are absorbed by the uranium 238, producing uranium 239, which is radioactively unstable and emits two beta particles one after the other, becoming plutonium—element 94, mass 239. In order to produce plutonium, even in small quantity, a large number of fissions must take place. Since each nuclear fission produces an amount of energy roughly 2,000,000 times that produced in the combustion of a hydrocarbon molecule, the production of plutonium is accompanied by the liberation of large quantities of energy. So far, this energy has been wasted, but potentially it may be very useful. The large reactors constructed at the Hanford plant, out on the Columbia River, are plutonium producers. The considerable quantity of energy which they produce from nuclear fission warms the Columbia River slightly but is put to no constructive use.

After uranium has been irradiated for some time in the nuclear reactor or pile, it becomes highly radioactive with fission products and also contains a very small amount of plutonium. In order to separate this from the fission products in uranium, a rather elaborate remote-control chemical plant is needed. This separation would not be extraordinarily difficult if this material were not highly radioactive. But to operate a complicated plant without being able to get into it at a critical time poses many problems. Research and development have not only been the foundation for the construction of nuclear reactors but have played an important role in the many developments which have taken place in the chemical processing.

The development of the first atomic bomb required research into properties of fissionable materials and a rather imposing amount of development work. Since that time, research and development on weapons have been carried on at the Los Alamos Laboratory, and many new facts about weapons have been learned. This work has led during the past year to successful tests of several newly developed weapons which were carried out in the Pacific last spring. The research and development carried on in connection with the weapons work ranges all the way from fundamental work in nuclear physics and chemistry to weapons development work and ordnance engineering.

A recent example of fundamental work at Los Alamos is, I believe, of unusual interest. Using a very small quantity of helium of mass 3, the condensation of that material was recently achieved. This is a point of considerable scientific interest because the properties of the condensed He^3 were expected to be very different from those of normal helium of mass 4, and it was even thought by some that it might not be possible to condense this material. It does, indeed, show quite different properties from ordinary helium at these low temperatures. The boiling point of He^3 is observed to be 3.19° above absolute zero compared to 4.3° for normal helium, and its vapor pressure at low temperature is very much greater than that observed for He^4. At 1.2° K, the vapor pressure is 35 times that observed for normal helium.

He^3 has been found to occur in very small amounts in natural helium. It is also obtained by the radioactive decay of hydrogen of mass 3, or tritium, which can be produced by the bombardment of lithium in a nuclear reactor. Both of these isotopes, which are of unusual interest for nuclear experimentation, have recently been made available in small quantities as part of the Commission's isotope distribution program. As you may know, the nuclear magnetic moments of both He^3 and H^3 have recently been studied and determined with some precision. The nucleus of H^3 is the simplest one showing radioactive decay. It has a half-life of 12 years, and the maximum energy of the beta particle is now believed to be about 18 kv. Recent measurements of the maximum energy of the emitted beta particle and of the half-life now make it appear that there is no serious disagreement with the theoretically expected relation between these two quantities. In spite of the extreme softness of this radiation, it now seems likely that H^3 may be extraordinarily useful as a tracer isotope.

Research and development work which is not directly connected with the production of fissionable materials or the development and production of atomic weapons forms a large part of the program of work in physical science research, biological and medical research, and in the development of nuclear reactors.

The Commission has a major program of research in biology and medicine. This was first undertaken during the war in connection with the production of radioactive materials and the health hazards accompanying them. It was soon found that, in addition to health problems, there were many inadequately understood medical and biological problems which arose due to the unknown effects of these radioactive materials. During the war, work in these fields was confined largely to that absolutely necessary for the production programs under way. Very little was done to understand the effects of radiation upon living cells.

The health work is now carried out on an even greater scale, since many more problems have arisen in connection with new methods of chemical processing and the greatly increased use of radioactive materials. In addition, a great deal of work is directed toward a better understanding of the effects of radiation upon living matter, and these studies include fundamental research in biology and medicine. Work is now under way to study the way in which radioactive materials are concentrated in various parts of the body, and similar studies have been made on plants.

Radioactive isotopes, which are proving to be an important means of finding new information in many sciences, are of particular importance in the complex problems in biology and medicine. Today, biological and medical workers are by far the greatest users of radioactive isotopes, and the possibilities are growing every day. Work now in progress in the biological sciences ranges from fundamental work on photosynthesis to practical problems on the use of fertilizers. It would be very difficult to overestimate the benefits the world could get from a better understanding of the processes by which plants accumulate solar energy.

An example of the medical uses of radioactive isotopes is some recent work at Tulane University. A study was made of patients with congestive heart failure. Due to the deficiencies in the pumping action of the heart, the saline solution of the blood backs up in various parts of the body, the lungs become water logged, the liver swells up, and there is a general condition of dropsy. By using radioactive sodium, it was definitely shown that the excretion of sodium was subnormal, and a drug was found which increases greatly the salt excretion and relieves the dropsy.

Another example is the work at Columbia University, where radioactive iodine has been used as a diagnostic aid in determining whether patients have a thyroid disorder. Radioiodine has also been used with success in many cases in the treatment of hyperthyroidism, and the same radioisotope has been used in radioautographic studies of primary thyroid cancer to give information which would point to possible therapy. These are but a few examples of the extensive use of one radioactive isotope in medical work.

Sometimes the work in radiation effects leads to an unexpected result. Since the plutonium production reactors are located on the Columbia River, attention has been directed toward studies of salmon. Dr. Donaldson, head of the School of Applied Fisheries at the University of Washington, has found in the course of these studies that new spawning grounds can be successfully established by the transplanting of spawn to suitable pools not previously used.

The work in biology and medicine is carried on in the various National Laboratories at Brookhaven, Oak Ridge, and Argonne, as well as at Rochester, Los Alamos, Berkeley, and at a very large number of universities and medical schools. The Commission is also supporting the Atomic Casualty Survey, a study made of the casualties suffered from the bombs dropped upon Hiroshima and Nagasaki.

In the physical sciences the work supported by the Atomic Energy Commission is predominantly in the fields of physics, chemistry, and metallurgy, although much of this work branches into the engineering phases of these sciences. A great deal of the work in the physical sciences, however, is directed toward fundamental research, since an effort is being made to encourage fundamental work in nuclear science, both in order to obtain a more complete understanding of the atomic nucleus and to provide trained scientists who may later take up applied work in atomic energy.

Our understanding of the atomic nucleus is today all too inadequate. While we have learned how to obtain energy in quantity from certain atomic nuclei, we do not know the origin of the forces holding the atomic nucleus together, and we have no explanation of most of the observed properties of atomic nuclei, such as their angular momenta and magnetic moments. Information on nuclear properties is now being added at an ever-increasing rate, and today, many fundamental properties of nuclei are known of which we were ignorant three years ago.

There have also been many exciting experiments with cosmic rays and with high-energy particles accelerated in giant machines. During the past year, the first man-made mesons were produced in the big cyclotron in Berkeley, and now it seems that there are probably several kinds of these intermediate mass particles which are produced by high-energy particles. Work upon these fundamental particles of physics is being carried on in Commission-supported laboratories and under a number of contracts with universities which have been supported jointly by the Commission and the Office of Naval Research.

The requirements of nuclear reactors have posed many interesting and difficult problems. Due to their unusual ability to absorb neutrons, it has become necessary to separate rather completely some elements from various materials with which they are usually found and in which they have frequently appeared as impurities because of their similar chemical properties. In some cases it has been necessary to reduce the content of such impurities in reactor materials to a fraction of a part per million. The effects of radiation upon materials in nuclear reactors have prompted a vigorous investigation of the solid state characteristics of certain materials. The whole subject of the solid state is, indeed, a difficult one, and the radiation effects upon materials are today only very incompletely understood. These effects constitute one of the major problems in reactor development, and some further basic understanding will certainly be necessary in the course of this development. The requirements of reactors have also led to the development of several new metals which have not been used previously due to their difficulty in preparation but which may prove to be the structural materials of the future.

The development of nuclear reactors is a subject which is just beginning to come into its own. At the end of the war, the optimism about the development of atomic power struck everywhere, and the technical difficulties were only just beginning to be understood. For example, radiation effects upon materials in reactors had been anticipated, but the seriousness of these effects and the difficulties to which they might lead were only partially foreseen. Radiation effects soon proved to be a reality, and the difficulties to which they led were serious. It became necessary to backtrack considerably in reactor development in order to take account of these effects.

The chemical problems of reprocessing nuclear fuel, or of extracting plutonium from irradiated uranium, have likewise proved to be a major headache. These chemical processes are costly and complicated, and involve tremendous outlays in plant. Disposal of the radioactive wastes obtained from these chemical plants has proved to be extremely difficult. During the past two years, considerable progress has been made in the development of new chemical processes which may prove to be more efficient and which may help in the disposal problem. The disposal of these products, which have sometimes been referred to by the uneuphonious name of atomic garbage, is much more difficult than the disposal of ordinary industrial wastes.

These hurdles in the development of nuclear reactors seem now to have been partially cleared, but we can by no means conclude that the production of electrical power from nuclear reactors is technically feasible, let alone economically feasible.

It seems very likely that new developments will make the production of electrical power from nuclear reactors technically feasible. But exactly how complicated such a plant will be and what its efficiency may be are points which are pretty much unknown. There are, indeed, whole sections of this work that are unexplored. For example, we know that the efficiency of a heat engine depends upon the difference in temperature of the thermal cycle. Nuclear reactors today operate at relatively low temperatures; thus, the temperature difference measured on an absolute scale is indeed small, and the efficiency necessarily low. In order to achieve higher efficiency, it will be necessary to operate nuclear reactors at much higher temperatures. This involves many technical developments, some of which may prove to be desirable for other reasons as well, but much new work is necessary.

The question of economic feasibility is one on which we can only speculate. It is true that various papers have been written on this subject, but it seems most unlikely that the question of economic feasibility can be sensibly commented upon until the technical situation is considerably clearer. We should remember, however, that the course of any new development, once its outlines have been clarified, is always to simplify and thus cheapen the process. Although the development of electrical power from nuclear reactors looks complicated and questionable from the economic standpoint, we can expect that future work will make this development considerably more favorable. In spite of this, it is far too early to make any predictions about the economic feasibility of atomic power.

On the technical side, the situation is much more promising but the developments are going to take some time. On a demonstration basis, electrical power will probably be developed from a nuclear reactor within the next two years. Within the next 8–10 years there will probably exist a prototype of a nuclear reactor for the production of electrical power in quantity. This unit, of course, will be preceded by smaller units. Two of these are now being designed and will soon be under construction, one at the Argonne National Laboratory and the other at the Knolls Atomic Power Laboratory near Schenectady.

Of course, the whole development of economic electrical power from nuclear reactors is but one aspect of reactor development. For some purposes, such as the propulsion of a ship, the nuclear reactor has peculiar advantages from the fuel standpoint. Here, the question of size, weight, and complexity of the nuclear reactor and its auxiliary equipment are of paramount importance. While no reactor, operating at the temperature presently used, could possibly prove to be a useful source of power for such a purpose, the use of higher temperatures may reasonably be expected to lead, in the not too distant future, to reactors which are suitable for this purpose. Whether or not the characteristics of such reactors are such that they will prove to be useful sources for ship or submarine propulsion will have to await the outcome of the development work. At the present moment, the prospects in this direction look favorable, and it seems likely that this will be the first application of a mobile nuclear reactor.

Many people have speculated upon the possibility of driving an aircraft by a nuclear reactor. Here there are many intriguing possibilities because of the extraordinary large energy content per pound of purified nuclear fuel. Unfortunately, nuclear reactors as we now know them are heavy. In particular, the shields for protection from the penetrating radiations produced inside must be very thick and heavy. Furthermore, the temperatures needed for aircraft nuclear reactors will probably need to be much higher than those which might be tolerated for driving a ship. In short, the problems here seem to be much more difficult.

The other day I read in a newspaper that someone had said that the theoretical work for the construction of a nuclear-powered aircraft was 99% complete. Probably he was misquoted, since there are certainly some important scientific problems yet to be solved. But the development of a nuclear-powered aircraft is primarily a technical and engineering problem—not a scientific one. Whether such a development will prove to be feasible can be determined only if a very great amount of new technical work is done.

In this connection it is interesting to note that the B-29 which was first used in combat in the later stages of the war was being designed prior to the discovery of nuclear fission. It took just about the same time to go from the discovery of nuclear fission through the production of experimental, pilot plant, and production chain reactors, through the extraction of purified fissionable material, to the development and construction of the atomic bomb that it took to proceed from the design of the B-29 to its actual use. This is by no means due to any lack of ingenuity and industry on the part of airplane manufacturers, but rather to the enormous complexity of the technical and construction problems which must be solved to make an airplane or airplane engine. We cannot expect the nuclear-powered aircraft to appear in the next few years, even if further work does indicate that it is feasible.

One of the most exciting prospects in the development of nuclear reactors is the possibility that one may be able to consume fissionable material, obtaining energy from this process, and at the same time utilize the neutrons thus produced to generate a larger amount of fissionable material than was destroyed. This subject is now being actively pursued. Whether or not it will be possible to achieve is not yet clear. In order to be practical, it will also be necessary to develop highly efficient chemical treatment of the nuclear fuel which must be reprocessed from time to time. It is a very intriguing possibility, and since the amount of new material which can be produced will depend both upon the intrinsic rate of production in the reactor and the amount of fissionable material thus committed, our stock of fissionable material may prove to be an even more precious possession than it seems today.

As you can see, research enters into almost every phase of atomic energy work. There is no sharp distinction between research and development. While there are a few examples where fundamental research can be set off by itself, it is more usual to find that development work often produces new leads for fundamental research and fundamental research shows the way to new possibilities for development and practical utilization of atomic energy.

Much has been made over the point expressed by some that atomic energy is of use only as an instrument of destruction. It is certainly true that our introduction to atomic energy was through the operation of the plutonium production reactor and the development of the atomic bomb. All work during the war was aimed at the development of the atomic bomb, but in the past three years we have seen the actual start of work in many other directions. The future holds quite a different picture. I believe that only those of myopic vision today believe that the long-range developments of atomic energy will not in time contribute very greatly to man's general well-being and cultural advancement if he can but stir up the wisdom needed to handle the tremendous forces which have been unleashed.

Preliminary Investigations of Chromosomes and Genes With the Electron Microscope

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A RELATIVELY SIMPLE METHOD of cutting and mounting sections sufficiently thin for effective use with the electron microscope was recently described by the present authors (*Proc. Soc. exp. Biol. Med.*, 1948, 67, 470). Section 0.2 μ thick were described originally, but with practice and minor improvements, 0.1-μ sections often have been obtained. We have started to apply this technique in a study of chromosome structure. Work has been initiated with the salivary glands of *Drosophila melanogaster*, fixed in the conventional manner by removing the glands directly within an acetocarmine mixture. This mode of fixation proved to be rather better than we had anticipated, even at the highest magnifications.

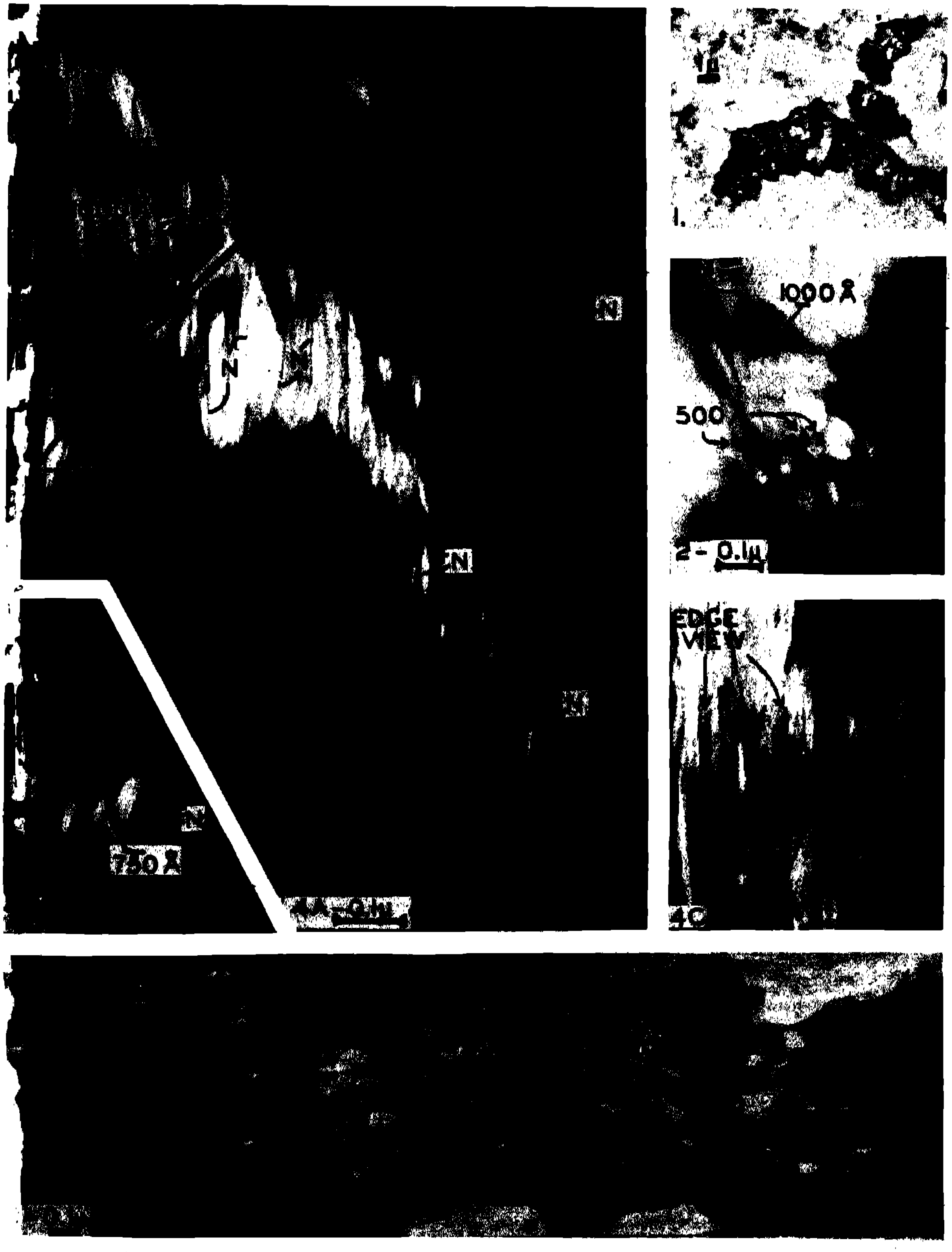
Before proceeding, it may be well to point out the known salient features of salivary chromosomes for those who are not familiar with their highly specialized organization. These are not ordinary chromosomes with single chromomere granules spaced along a single chromonemal thread. Instead, each primordial chromosome has reduplicated itself many times over. The end-product is a giant multiple chromosome made up of hundreds, if not thousands, of identical units.

Work with low magnifications disclosed particularly that the chromomere bands were very dense—far denser than any other cellular constituent. One has only to glance at Fig. 1 to be impressed with the difference between the substance of the chromomeres and the nucleoplasm. Since the electron image is a function of atomic and molecular density, it is possible to state definitely that chromomeres cannot have much water within them. The great density of the chromomeres has, in fact, been a major source of difficulty in attempts to employ high magnifications to resolve their structure. Excellent detail could be seen in any portion of a 0.1-μ section except within chromomeres. The latter have been visualized effectively only when their thickness was substantially less than 0.1 μ. This has occurred at the edges of sectioned chromosomes where their substance tapered (as in Fig. 2), or when sections had pulled apart somewhat to produce particularly thin areas (as in Fig. 4). Under those circumstances chromomeres have been resolved into their unit particles.

It will be convenient to begin our detailed discussion with Fig. 3, which shows a chromosome at moderate magnification for the electron microscope. The general relations show well, although fine detail is lacking. Chromomere granules arranged in bands are readily visible, the larger ones, however, being opaque to the electron beam. The lighter bands contain smaller granules usually aranged more diffusely. In one region, isolated 800-A particles are visible. The matrix is coarsely vacuolated—undoubtedly a fixation artifact, for the proteins of any greatly hydrated portion of a cell always are precipitated as a fibrous [illegible] Between the vacuoles a mesh of relatively heavy [illegible] exists, too large and irregularly arranged to be identifiable directly with chromonemata. This figure shows most of the relations (and artifacts) that can be [illegible] readily. One point that can be established definitely at this magnification is the fact that no limiting membrane can be found at the surface of the chromosome.

Under circumstances outlined earlier, detail was seen within chromomeres, but micrographs showing this clearly have been rarities. The remaining discussion will be based upon about a dozen pictures, although many more suggest and confirm the relations to be considered. Figs. 2 and 4 have been chosen to illustrate the unit particles of chromomeres, but some discussion of their general relations seems necessary. Fig. 2 was from the edge of a chromosome. Three completely dense chromomere bands can be seen to the right. To the left, 500-A particles in isolation, and also a small cluster of 1,000-A particles, can be seen. The larger particles were quite obviously related [illegible] much heavier band than were the smaller ones.

Figs. 4, A, B, and C, are the most revealing electron micrographs obtained so far. The original micrographs have a resolution of at least 30 A, although detail is lost in reproduction. All are of the [illegible] preparation, but unfortunately, the plane of section was quite oblique to the long axis of the chromosome. The individual bands tend to be shingled, one [illegible]lapping the next. The course of the bands is [illegible] horizontal, as can be seen in 4B and at the upper [illegible] of 4A. The section was actually rather thick, [illegible] clefts opened to disclose thin areas.



Electron micrographs of *Drosophila* salivary chromosomes: Fig. 1, × 3,600; Fig. 2, × 76,000; Fig. 3, × 49,000; Fig. 4, 20,000. Chromonemata are designated by N. Particle lengths are expressed in Angstrom units.

In Fig. 4, wherever one sees detail in the chromomere bands, one gets the impression of spindle-shaped particles. In this and other micrographs, whenever the spindles showed to good advantage, they had a uniform density across their width, indicating that the particles were flat plates. If they had had circular cross sections, the center axis would have been denser and blacker than the sides. Variations in the particle width within a single band further suggests that flat plates were being viewed obliquely, as though tilted in varying amounts. In Fig. 4C a few are thought to be seen on edge. The 1,000-A particles of Fig. 2 are of the same leaf shape. In fact, this seems to be very decidedly the most common type of unit particle which has been seen more or less clearly in a number of electron micrographs.

Particles having other configurations have been seen, however. These were globular in character rather than flattened in one plane. The type we have observed best and most often was asymmetrical. The 500-A particles of Fig. 2 are examples. We have good evidence of cigar-shaped particles, and others appeared to be essentially spherical. It should be stressed that within any one band the particles appeared to be nearly uniform. Even in Fig. 2, the small particles were presumably identical, the difference in appearance resulting simply from their being viewed from different angles.

The unit particles of the chromomere bands quite certainly were not of constant size from one band to another. Approximate lengths of some that can be measured most accurately are indicated on the figures. Because of the oblique section of Fig. 4, the lengths there may be deceptively low. Particles ranging up to almost 1,500 A have been seen in other micrographs. Particles of 500 A are the smallest that have been seen clearly, although there is some reason for believing that somewhat smaller ones exist. The particular particles of the left center of Fig. 4C are of about average size—approximately 750 A long and not more than 80 A thick. Although their width cannot be determined very accurately, it is probably about 250 A. The particle volume would therefore be of the order of $10^7 A^3$.

We have seen enough electron micrographs to realize that the grosser morphology of the bands is to some extent a reflection of the character of their unit particles. Particles of different shape apparently tend to aggregate in different manners. The most striking example is a very regular and uninterrupted alignment of cigar-shaped particles which has been observed to produce a band that would appear as a sharply defined, nongranular line in the light microscope. The leaf-shaped particles often were seen aggregated to form rather large granules, more or less fused with one another. This is the type of dense band visible in Fig. 3 and would definitely appear coarsely granular in the light microscope. Globular particles usually were observed only in small aggregates (Fig. 2 is an exception). The small granules so formed tended to exist in isolation and to be scattered. The light microscopist would see such bands as diffuse structures, very finely granular. No doubt other as yet undiscovered relations exist, and the time may come when these can be expressed more precisely.

There is an interesting corollary of these findings. Since the chromomeres are composed exclusively of the unit particles, and since theory (and our own observation) demands that every band contain the same number of units, the volume of stainable material in a band should be a function of particle size. If these particles can be identified as genes, gene size probably can be estimated with the light microscope.

Before leaving the discussion of the unit particles, it will be wise to consider the possibility of fixation artifact. The degree and kind of artifact cannot be established with certainty without much further work employing other means of fixation and probably lyophilizing techniques. However, since the particles which have been observed had complex shapes, they cannot be dismissed lightly. Furthermore, these shapes are related to what the light microscopist can observe in living material as well as in fixed preparations. Finally, we have presented incontrovertible evidence that the particles are not greatly hydrated, so that there is no reason to expect major changes. The principal artifact may well amount to nothing more than some shrinkage.

We have emphasized that the hydrated matrix of the chromosome was not well preserved; we believe, nevertheless, that we often have seen chromonemata. In electron micrographs with good resolution thin fibrils commonly were seen extending away from unit particles toward adjacent bands. Usually they were attached to the tapered tips of particles, but the globular particles sometimes seemed to be attached at c side. A few micrographs showed these filaments great profusion. Under favorable circumstances, a single fibril could be traced from a particular particle of one band to one of the next as in Fig. 4B. Where these fibrils are most conspicuous in the figures, they have been designated by the letter N. No clearly defined chromonemata have been observed that were thicker than about 80 A. The thinner fibrils, probably stretched, were sometimes less than 50 A thick.

Even though this work must be regarded as in its early stages, we have been impressed by the close

(*Continued on page 22, column 2.*)

TECHNICAL PAPERS

Effect of Absorber Position on Counting Rate of Collimated and Uncollimated Beta and Gamma Radiation[1]

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Although it is generally recognized that, because of scattering effects, the observed counting rate of a radioactive sample depends on the atomic number and geometrical arrangement of absorbers and surrounding material (e.g. *1–9*), we do not know of any published data which show how greatly the counting rate may depend on the position of an absorber foil placed between a fixed sample and detector. The data of Tables 1 and 2 illustrate this dependence and the fact that a variation in absorber position in a collimated beam of radiation may have an effect opposite to that of a similar variation in position in uncollimated radiation. These effects may be explained with the aid of the schematic diagram given in Figs. 1 and 2.

TABLE 1

EFFECT OF POSITION OF ABSORBER ON THE COUNTING RATE OF UNCOLLIMATED RADIATION FROM A RADIOACTIVE SAMPLE

Test*	Type of radiation	Absorber	†Distance (cm) of bottom of absorber from: Sample	G-M tube window	Cpm*
1	Beta, 1.69 Mev, max.	109 mg/cm^2 of Pb	0	5.4	3,712
			1.5	3.9	3,200
			3.0	2.4	2,528
			4.5	0.9	1,856
2	Beta, 1.69 Mev, max.	120.7 mg/cm^2 of Al	0	5.4	6,368
			1.5	3.9	5,568
			3.0	2.4	4,512
			4.5	0.9	4,288
3	Gamma, 1.3 Mev and 1.1 Mev	920 mg/cm^2 of Pb	0	5.4	2,052
			1.5	3.9	1,577
			3.0	2.4	1,377
			4.5	0.0	1,184
4	Gamma, 1.3 Mev and 1.1 Mev	870 mg/cm^2 of Al	0	5.4	2,040
			1.5	3.9	1,557
			3.0	2.4	1,318
			4.5	0.9	1,233

* Different radioactive samples and different Geiger-Müller tubes were used in different tests, so the relation of the absolute counting rates of different tests has no significance.

† Fig. 1.

In the case of the collimated beam (Fig. 2) a certain fraction of the radiation, represented by A, is transmitted through the absorber without scattering regardless of the position of the horizontally placed absorber between the sample and the detector. The remaining radiation is scattered with an angular distribution which is independent of the distance of the absorber from the detector window, but the fraction of such radiation entering the window is dependent on this distance. This is illustrated by the radiation labeled B_I, which is scattered from an absorber in position I at such an angle that it does not enter the detector window, while the identical radiation, B_{II}, scattered at the same angle from an absorber in position II, does enter the window.

TABLE 2

EFFECT OF POSITION OF ABSORBER ON THE COUNTING RATE OF COLLIMATED RADIATION

Test*	Type of radiation	Absorber	†Distance (cm) of bottom of absorber from: Lead block	G-M tube window	Cpm*
1	Beta, 1.69 Mev, max.	50.7 mg/cm^2 of Pb	1.5	5.8	812
			3.0	4.3	425
			4.5	2.8	661
			6.0	1.3	1,045
2	Beta, 1.69 Mev, max.	120 mg/cm^2 of Al	1.5	5.8	369
			3.0	4.3	491
			4.5	2.8	737
			6.0	1.3	1,185
3	Gamma, 1.3 Mev and 1.1 Mev	465 mg/cm^2 of Pb	1.5	5.8	672
			3.0	4.3	672
			4.5	2.8	704
			6.0	1.3	832
4	Gamma, 1.3 Mev and 1.1 Mev	445 mg/cm^2 of Al	1.5	5.8	704
			3.0	4.3	720
			4.5	2.8	786
			6.0	1.3	848

* See Table 1.

† Fig. 2.

When the radiation is not collimated (Fig. 1) the effect illustrated in Fig. 2 still occurs for those radiations in the direct cone of the solid angle subtended by the counter window, but a larger effect, due to the decrease in the total amount of radiation intercepted by the absorber as it is moved from the sample toward the detector, is superimposed. This is illustrated by the radiation labeled C_{IV}, which escapes the absorber and counting tube completely when the absorber is in position IV but which has a certain probability of being scattered along the direction C_{III} and entering the detector if the absorber is in position III.

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[1] The work reported here has been supported in part by the Research Committee of the Graduate School from funds supplied by the Wisconsin Alumni Research Foundation.

The effect of absorber position depends, of course, upon area and thickness of the absorber, energy of the radiation, and degree of collimation of the beam. Under some conditions a minimum in the counting rate may occur as the absorber is moved from the sample toward the detector. A specialized case of the effect illustrated in Fig. 1 is the "self-focusing" which often leads to an initial increase in counting rate of a radioactive sample of constant disintegration rate as it is diluted with inactive material.

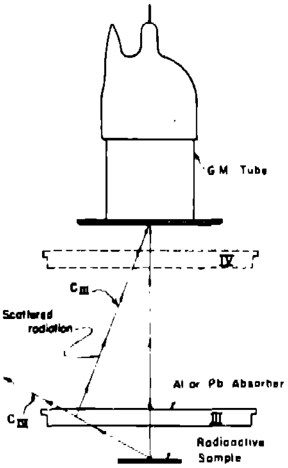

FIG. 1. Illustration of the effect of the position of an absorber on the counting rate of uncollimated radiation.

A radioactive sample mounted as in Fig. 1 gives a lower counting rate through a pile of thin absorbers placed loosely on top of the sample than through a single thick absorber of the same total surface density. For example, when an 1,850 mg/cm² lead absorber in uncollimated gamma radiation from Co^{60} was replaced by 5 single absorbers of thicknesses 916, 434, 234, 234, and 36 mg/cm² totaling 1,854 mg/cm², the counting rate fell from 1,260 cpm to 924 cpm. This is presumably due to the greater average distance from the sample of the absorbing material in the loosely piled absorbers and a consequent decrease in scattering of the type illustrated in Fig. 1.

Since most radioactive tracer work requires only a knowledge of the relative counting rates of samples which can be counted under nearly identical conditions, the phenomena discussed here need not be a serious handicap in such investigations.

The data of Table 1 were obtained using an unshielded, brass, bell-shaped, Geiger-Müller counter tube mounted in a conventional Lucite stand provided with slots for reproducibly placing samples and absorbers. The 1¼"-diameter mica window of the tube was 5.4 cm from the radioactive sample spread on a 1" watch glass resting in a cardboard holder, the backing of which was the wooden desk. The data of Table 2 were obtained in the same manner, except that the radioactive sample was placed at the bottom of a hole 1.5 cm in diameter and 15 cm long in a lead block. The distance from the counter window to the top of the lead block was 7.3 cm, and the geometrical relationships were such that the diameter of the collimated beam of radiation at the counter window was less than the diameter of the window. Tests of the effect of absorber position on the counting rate were made with both aluminum and lead absorbers (2½" × 3½" in area) with both the beta radiation of P^{32} (1.69 Mev, max. energy) and the gamma radiation of Co^{60} (1.1 and 1.3 Mev). The absorbers used were thick enough to cut out the 0.3-Mev Co^{60} beta radiation.

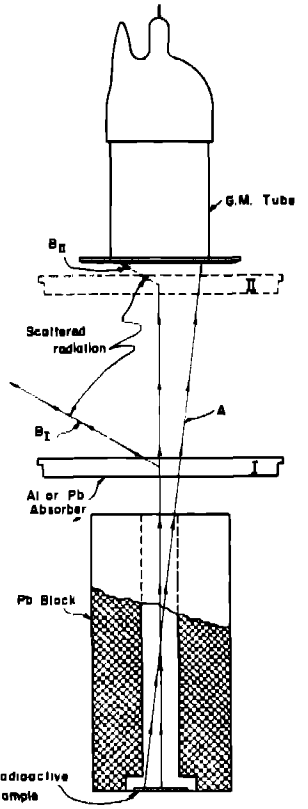

FIG. 2. Illustration of the effect of the position of an absorber on the counting rate of collimated radiation.

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Oxidation of Parenterally Administered C^{14}-labeled Tripalmitin Emulsions[1]

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The question whether long-chain fatty acids can be utilized when administered by routes other than the gastrointestinal tract has aroused considerable interest in recent years. Dunham and Brunschwig (*2*) failed to observe protein-sparing effects in 9 of 11 dogs when a highly emulsified fat was injected intravenously for periods as long as one month. The emulsions used, however, were quite toxic. McKibbin, *et al.* (*4*), on the other hand, have drawn the conclusion that intravenously administered emulsions of fat are utilized, for not only did they find weight improvement and nitrogen retention in 2 dogs, but, in addition, they were unable to account for a considerable portion of the infused fat by finding it stored in an unmodified form. Meng and Freeman (*5*) also noted a gain in body weight in dogs that received fat emulsions intravenously, but they point out that such results furnish no direct proof of fat utilization.

The use of radioactive carbon provides for the first time a direct method for determining whether an animal can convert parenterally administered fatty acids to CO_2. Palmitic acid containing C^{14} in the sixth carbon atom

$$C_{10}H_{21}C^{14}H_2CH_2CH_2CH_2CH_2COOH \qquad (1)$$

(I) was synthesized as described in an earlier communication (*1*) and then esterified with glycerol by a modification of the method of Feuge, *et al.* (*3*). An emulsion of the tripalmitin was prepared with glycerol monostearate as the stabilizer and the fat dispersed into particles of less than 2 μ by means of supersonic energy. One or 1.5 cc of this emulsion containing 25 mg of tripalmitin was then injected into the foot vein of fasted rats weighing 175 gm. The expired CO_2 was collected and its C^{14} determined. Typical results are shown in Table 1.

TABLE 1

RECOVERY OF C^{14} IN THE EXPIRED CO_2 OF A RAT INJECTED INTRAVENOUSLY WITH A FAT EMULSION CONTAINING TRIPALMITIN IN WHICH THE PALMITIC ACID WAS LABELED WITH C^{14}*

Interval (hrs)		0–2	2–4	4–6	6–19	19–24	Total
C^{14} in expired CO_2	Rat 1	7.2	10.2	8.6	20.6	4.3	50.9
	Rat 2	6.4	13.7	7.7	24.2	4.5	56.5

* The values recorded are percentages of the total injected radioactivity.

In the first 2 hrs approximately 7% of the injected C^{14} was found in the expired CO_2, and at the end of 24 hrs about one-half of the radioactivity was exhaled. The maximum rate of $C^{14}O_2$ exhalation was observed between the 2nd and 4th hrs. These results indicate that about one-half of the administered palmitic acid had been metabolized in 24 hrs.

The data presented here justify the conclusion that emulsified fat introduced directly into the blood stream is available for caloric purposes. Further evidence that parenterally administered emulsified fat pursues a normal metabolic path was provided by the finding that about 50% of the injected C^{14}-labeled fatty acids recovered in the liver had been incorporated into phospholipids at the end of 24 hrs.

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[1] This investigation was supported by a grant from the American Cancer Society (recommended by the Committee on Growth) and the Cutter Laboratories.

Life Cycle of *Postharmostomum laruei* McIntosh 1934 (Trematoda: Brachylaemidae)

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The adult trematode, *Postharmostomum laruei* McIntosh 1934 (Brachylaemidae), has been experimentally developed in this laboratory in the deer mouse, *Peromyscus maniculatus* (various subspecies), as the final host.

McIntosh (*1*) described the adult, specimens of which he obtained from the cecum of the chipmunk, *Tamias striatus lysteri* (Richardson). The metacercaria and adult of this species were described by Miller (*2*) in an abstract of an unpublished doctoral dissertation, in which he named this species *Brachylaima (Postharmostomum) sexconvolutum*. An examination of Miller's thesis, however, shows conclusively that his material included at least two species. Apparently aware of the synonymy and without referring directly to his published abstract, Miller (*3*) reported on the growth rate of this parasite, now referring to it as *Postharmostomum laruei* McIntosh.

My interest in the completion of the life cycle of this species was aroused when the metacercarial stages of the parasite were encountered repeatedly during examination of land snails in the vicinity of Ann Arbor, Michigan. The metacercariae are found within the pericardial cavity of the following land snails: *Anguispira alternata*, *Polygyra thyroides*, *P. profunda*, *P. multilineata*, *P. fraudulenta*, *P. hirsuta*, *Gastrodonta ligera*, and *Zonitoides ar-*

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[1] Contribution from the Department of Zoology, University of Michigan, under the direction of Dr. George R. LaRue.

boreus. In slugs, too, the metacercariae occur within the pericardial cavity. Only two species of land snails thus far examined (*A. alternata* and *P. fraudulenta*) harbor this species to the exclusion of all other brachylaemids. The number of metacercariae found within the pericardial cavity varies from one to many. Particularly in *A. alternata*, the number per snail is frequently above 50, and one snail contained 83 fully developed metacercariae. In general, metacercariae within the pericardial cavity may be divided into three recognizable age groups. Those fully developed are ovoidal, with well-established genital fundaments and exhibiting little or no movement. Very young metacercariae are characterized by the presence of a rudimentary tail, whereas intermediate forms are more elongate and tailless and show a considerably greater motility. All specimens differ from other members of the family found in snails in this area by the lack of ciliated excretory tubules. All three age groups may be present within the pericardial cavity of the same snail, indicating that immunity to the cercariae is not established following infection.

Observation showed that entrance of cercariae to the pericardial cavity occurs via the respiratory aperture. From this point, they are assumed to migrate through the excretory duct to the kidney and thence, by way of the renopericardial connection, to the heart chamber itself. Growth of metacercariae is extremely slow; feeding experiments in progress show that at 18 weeks the metacercariae have not yet reached full size.

When fully developed metacercariae were fed to laboratory-reared *Peromyscus*, adults of varying ages were secured from the cecum of the host. Attachment to the cecal walls and ingestion of blood commence within a very few hours after feeding. Adult flukes have been maintained in *Peromyscus* for as long as 100 days. Egg production commences on the 8th or 9th day, while fully embryonated eggs appear in the feces about the 20th day. All attempts at securing discharge of eggs from living worms have been unsuccessful.

Published data dealing with members of this family have shown a conspicuous lack of information concerning the miracidial stage, primarily because of difficulties encountered in freeing the miracidia from the egg shells. Miller (*2*) concluded that the miracidial stage is nonexistent for this form. Hatching of the miracidium of *P. laruei* has been observed by me, and work is now in progress in an attempt to determine its morphology. Movement of the miracidia within the eggs can be seen after the crushed adults have been placed in saline; but emergence was noted only after the adults had been kept under refrigeration several days in normal saline and then transferred to tap water, crushed, and the eggs removed.

Eggs containing fully developed miracidia were fed to laboratory-reared specimens of *A. alternata* and various species of *Polygyra*. Branching sporocysts containing immature cercariae were found only in *A. alternata* after several weeks, while mature cercariae emerged between 3 and 7 months after exposure, depending upon temperature conditions. It is noteworthy that, although snails infected with the metacercarial stage are abundant in nature, averaging from 85 to 100% infection in localities near Ann Arbor where this parasite is found, the number of snails harboring sporocysts and cercariae is exceedingly small, since only 15 individuals of more than 3,200 examined to date by techniques involving the crushing of the snail have shown these stages. Moreover, fully developed cercariae emerged from only 5 of these 15. During the examination of a great variety of terrestrial snail hosts, sporocysts of other species of Brachylaemidae have been found, but those of *P. laruei* were found only in *A. alternata*, indicating specificity of this species of snail to infestation with the sporocyst of *P. laruei*.

A detailed account of this life cycle with complete descriptions of all stages involved is in preparation and will appear elsewhere.

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Distribution of Free Amino Acids in Mouse Epidermis in Various Phases of Growth as Determined by Paper Partition Chromatography

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Washington University School of Medicine, St. Louis, and
Department of Pathology,
University of Rochester School of Medicine and Dentistry

This is part of a series of experiments the purpose of which is to characterize the nitrogen metabolism of mouse epidermis in various phases of growth.

In the experiments to be reported a survey was made of the free amino acids found in alcoholic extracts of whole epidermis obtained from newborn mice (0–4 and 7 days of age), from normal adult mice, and from mice receiving 3, 6, or 12 applications of methylcholanthrene in benzene or 3 applications of benzene alone. A transplantable squamous cell carcinoma originally derived from a carcinoma produced on the skin of a mouse by the application of the carcinogen was also studied. The method of treatment of the animals and preparation of the tissues has been described (*6*). The tissues were dried *in vacuo* over P_2O_5, ground, and redried to constant weight. Samples (200 mg) of the tissues studied were stirred thoroughly with 1 ml of 76% alcohol at room temperature, and determinations by the two-dimensional chromatographic method (*1, 2, 4*) were made on 75 µl of the untreated extract and on similar aliquots after oxidation with H_2O_2 and after hydrolysis with HCl. The amino

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[1] Aided by grants from the Charles F. Kettering Foundation and the National Cancer Institute.

acids were identified by their relative positions on the paper square and by comparison with a reference chromatogram prepared by Dent (*3*). A diagram showing the positions of the ninhydrin-reactive substances found in the samples is shown in Fig. 1. Spot X was given by glutathione either in pure solution or on addition to a casein digest. On treatment of either solution by H_2O_2, this spot was shifted to position V. It is interesting that, of these two spots, only V was observed in *untreated* extracts of all the tissues examined with the exception of the tumors, in which case only spot X was found.

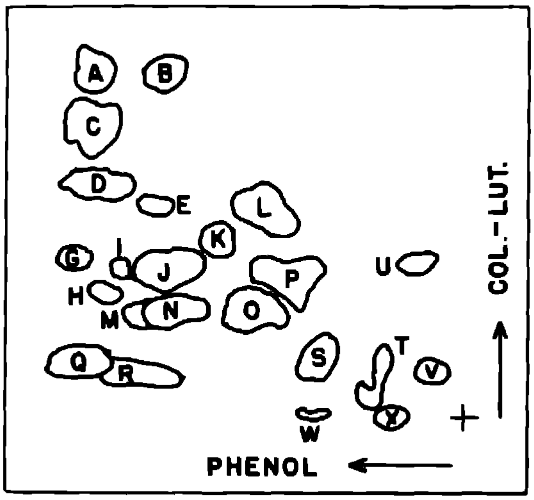

FIG. 1. Diagram of constituents of chromatograms made from epidermal and tumor extracts: A, phenylalanine; B, tyrosine; C, leucine; D, valine; E, methionine sulfone; G, proline; H, histidine; I, hydroxyproline; J, alanine; K, threonine; L, taurine; M, β-alanine or citrulline; N, glutamine or serylglycylglycine; O, glycine; P, serine; Q, arginine; R, lysine; S, glutamic acid; T, aspartic acid; U, cysteic acid; V, "oxidized" glutathione; W, "underglutamic acid," unidentified; X, glutathione.

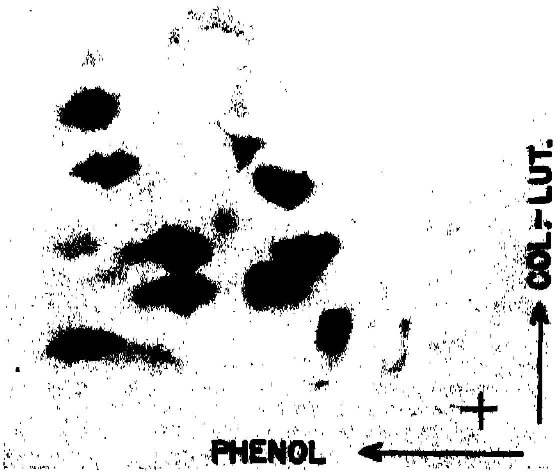

FIG. 2. Peroxide-treated extract of epidermis after 6 paintings with methylcholanthrene in benzene.

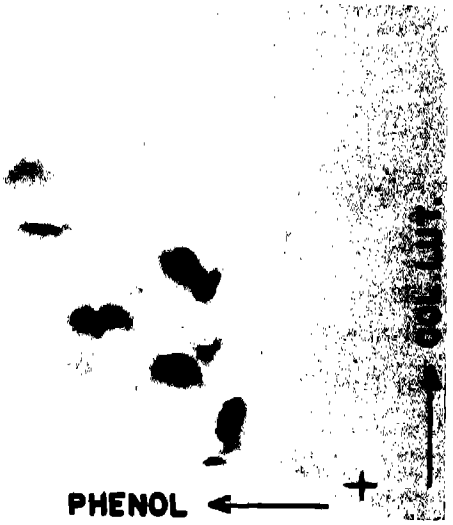

FIG. 3. Extract of squamous cell carcinomata.

In a previous investigation (*5*) it was found that the amino acid pattern of whole tumor tissue was significantly different from that of normal epidermis, but similar in most respects to that of the nonmalignant hyperplastic epidermis produced by the application of methylcholanthrene. The present study shows that the carcinoma can be sharply differentiated from the latter tissue on the basis of the distribution of free amino acids in the alcoholic extracts (Figs. 2 and 3). The tissue made hyperplastic by the application of the carcinogen and the epidermis of newborn mice had greater over-all concentrations of the detectable constituents than the normal adult epidermis, while the tumors showed a striking decrease. Only the "underglutamic acid" and cystine spots (the latter not appearing on this photograph) in the tumors had a greater intensity than in the other samples. The over-all decrease in free amino acids found in the tumors is even more impressive when it is recalled that a given fresh weight of this tumor contains only approximately one-half of the dry weight found in the same fresh weight of normal or hyperplastic epidermis (*6*). There was a retardation of the movement of the amino acids in the tumor extracts in the phenol direction which disappeared after acid hydrolysis. This phenomenon, which is often associated with the presence of constituents of high molecular weight, such as polypeptides, is under further investigation. The application of pure benzene produced marked increases in proline and lysine contents, a decrease in the taurine level, and little or no change in the other constituents.

The epidermis of newborn mice and hyperplastic epidermis, both of which tissues have a more rapid rate of growth than normal adult epidermis, had greater concentrations of free amino acids than the latter tissue, while the rapidly growing carcinoma had a much lower content than normal. This suggests that the growth in the nonmalignant epidermis may be associated with the ability of the cells to increase the intracellular concentrations of the amino acids necessary for protein synthesis, whereas in the malignant tumor the mechanisms for protein synthesis are much more efficient and can operate at a greatly accelerated rate, even in the presence of smaller concentrations of amino acids.

Several aspects of this work are being studied further.

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Blocking Action of Tetraethylammonium on Axon Reflexes in the Human Skin

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Tetraethylammonium (*4*), which is now enjoying a wide trial as a diagnostic and therapeutic agent, is believed to exert its effects by the specific blockade of autonomic ganglia (*1*, *2*). It is of interest, therefore, that in connection with some studies of the autonomic pharmacology of the skin we have obtained evidence that tetraethylammonium may exert an action on peripheral nerve fibers.

In most individuals the intracutaneous injection of acetylcholine in appropriate concentrations induces pilomotion and sweating, which occur very promptly after injection of the drug and extend for a considerable distance from the site of injection. These responses have been shown to be due to axon reflexes dependent on the integrity of the postganglionic sympathetic fibers (*5*).

By previously infiltrating the skin with tetraethylammonium we have been able to inhibit the axon reflexes of pilomotion and sweating induced by acetylcholine.

Pilomotion was elicited by the intracutaneous injection of 0.1 ml of acetylcholine hydrobromide, 1: 25,000; axon reflex sweating, by the injection of 0.1 ml of acetylcholine hydrobromide, 1: 500. Sweating was demonstrated by the ferric chloride–tannic acid method of Silverman and Powell (*6*). Axon sweating must be distinguished from the local response, which is confined to the area of the wheal, and from the sweating which follows the lymphatic diffusion of acetylcholine. Areas of the volar aspects of both forearms were selected for each test. The control area was prepared by the intracutaneous injection of 0.1 ml of physiological saline. The corresponding contralateral area was prepared by the intracutaneous injection of 0.1 ml of tetraethylammonium chloride, 1: 100.

It should be noted that tetraethylammonium itself, in the range of 1:10 to 1: 100,000, does not induce pilomotion or sweating.

In 15 experiments on 7 subjects in no instance did pilomotion occur when acetylcholine was injected into the spot where tetraethylammonium had been injected 1–2 min previously. Injection of acetylcholine into the control area treated with saline in every test produced typical pilomotion over an area of 2–3 cm in diameter surrounding the injection site and lasting for 45–90 sec. In 12 experiments on 8 subjects axon reflex sweating was either completely inhibited or markedly suppressed when acetylcholine was injected into the spot where tetraethylammonium had been injected 1–2 min previously. The local sweat response was not impaired. Injection of acetylcholine into the control area treated with saline in every instance produced typical axon sweating over an area of 2–4 cm in diameter.

Since these axon reflexes of the skin depend on the integrity of the postganglionic sympathetic axon and since they are blocked by the presence of tetraethylammonium locally in the skin, it is presumed that the blockade occurs along the course of the efferent sympathetic fibers in the skin.

The only other theoretically possible site of the stimulating action of acetylcholine and the blocking action of tetraethylammonium is the neuro-effector junction. In any case, there are no ganglion cells in the skin, although these axon reflexes occurring over the peripheral neural apparatus behave pharmacologically as though the site of stimulation were an autonomic ganglion. Rothman and Coon (*5*) pointed out this similarity and demonstrated that, as in the autonomic ganglia, nicotine or α-lobeline could be substituted for acetylcholine as the stimulus. The present study reveals a further similarity, namely, the blocking by tetraethylammonium of the nicotinic stimulating action of acetylcholine.

Evidence of the specificity of this blocking effect is the fact that we have been unable to inhibit with tetraethylammonium the flare which surrounds histamine-induced wheals of the skin, an axon reflex which is dependent on the integrity of afferent fibers of the skin (*3*).

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Further Consideration of a Suggested Simple Laboratory Test for Poliomyelitis Virus[1]

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A preliminary note (*1*) reported findings which suggested that an interference phenomenon may have resulted in a relative protection of mice, inoculated with material containing poliomyelitis virus, against a subsequent inoculation with the Lansing strain of virus. It was hoped that these findings might become the basis of a simple laboratory test for the presence of poliomyelitis virus.

TABLE 1

EFFECT OF PRELIMINARY INTRACEREBRAL INOCULATION OF EXTRACTS OF HUMAN STOOL OR MONKEY SPINAL CORD, CONTAINING OR FREE OF POLIOMYELITIS VIRUS, ON REACTION OF MICE TO SUBSEQUENT INTRACEREBRAL INJECTION OF LANSING VIRUS

Material injected intracerebrally 2 days before Lansing virus			No. of mice paralyzed or dead at indicated time after intracerebral injection of Lansing virus (1×10^{-2})*		
Group	Type	Strain	10 days	14 days	28 days
Presence of poliomyelitis virus in aliquot samples demonstrated by tests in monkeys	Stool	J.H.	7/10	9/10	10/10
	"	E.D.	6/10	7/10	10/10
	"	D.Y.	4/10	6/10	6/10
	"	L.W.	4/10	8/10	9/10
	Monkey spinal cord†	B.H.	5/10	6/10	9/10
	"	L.W.	5/10	5/10	7/10
	"	J.F.	5/10	7/10	9/10
	"	J.R.	4/10	0/10	9/10
	"	J.H.	8/10	4/10	9/10
No poliomyelitis virus found by tests in monkeys	Stool	....	0/10	6/10	10/10
	"	....	5/10	8/10	10/10
Normal monkey spinal cord			4/10	7/10	9/10
No preliminary inoculation Lansing virus controls	10^{-2}	Group I	7/10	9/10	9/10
		Group II	6/10	6/10	7/10
	10^{-3}		3/10	5/10	8/10
	10^{-4}		0/10	0/10	6/10
	10^{-5}		0/10	0/10	1/10

* Based on the control titer of this virus at 28 days, this dose contains 50 PD$_{50}$ of virus.

† Strains of human origin—second or third generation in rhesus monkeys.

Since the preliminary report was based mainly upon the results obtained with extracts of 5 individual human stools collected during a single epidemic period, it was considered desirable to repeat the experiments on a larger scale with different strains of virus. The availability in the Cincinnati laboratory of a number of frozen specimens of known potency, based on recent tests in monkeys, permitted prompt repetition of this work.

The results of these tests, shown in Tables 1 and 2, indicated that (a) the incubation period among different groups of mice inoculated with the Lansing virus alone was much more variable than appeared to be the case in the preliminary tests, and (b) intracerebral inoculation of mice with strains of poliomyelitis virus of proved pathogenicity for monkeys does not interfere with the action of the Lansing strain, regardless of whether or not those strains are immunologically related to it.

TABLE 2

EFFECT OF PRELIMINARY INTRACEREBRAL INOCULATION OF THE IMMUNOLOGICALLY RELATED "MV" VIRUS ON REACTION OF MICE TO SUBSEQUENT INJECTION OF LANSING VIRUS

Series	Group*	No. of mice paralyzed or dead at indicated time after inoculation of Lansing virus 1 : 50		
		10 days	14 days	28 days
0.03 cc of 20% suspension of monkey spinal cord—"MV" virus—injected intracerebrally 2 days before Lansing virus	I	5/5	5/5	5/5
	II	3/5	5/5	5/5
	III	3/5	5/5	5/5
	IV	3/5	4/5	5/5
	V	1/5	4/5	5/5
No preliminary inoculation Lansing virus controls	I	5/5	5/5	5/5
	II	4/5	5/5	5/5
	III	3/5	4/5	4/5
	IV	2/5	3/5	5/5
	V	2/5	3/5	4/5

* All mice were inoculated simultaneously with the same material and divided into groups of 5 each in order to determine the random distribution of paralysis and death in samples of this size.

The tests were also repeated in the Paris laboratory with extracts of the stools used in the original tests, and the results were similar to those shown in Tables 1 and 2—irregularity in the prolongation of the incubation period among the preinoculated mice, and greater variation than was previously observed among the controls.

The results of this work lead to the conclusion that interference with the Lansing virus in mice cannot be the basis of a simple laboratory test for poliomyelitis virus. It is also noteworthy that Sabin and Ward (*2*), who tested many strains of poliomyelitis virus of recent human origin for their capacity to protect mice against a challenge dose of Lansing virus administered 2 months after the original inoculation rather than 2 days, as in the present tests, also obtained only negative results.

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[1] Aided by a grant from the National Foundation for Infantile Paralysis.

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Comments and Communications

A Note on "Why Vegetation on Watersheds?"

The writer would like to add a couple of items apparently overlooked in the recent note by Chapman Grant (*Science*, October 29, p. 486). First, watersheds that have reservoir storage for the entire annual precipitation are quite rare. In southern California a large part of the water conserved is put underground by percolation of slowly released impounded stream flow. Complete storage is unnecessary as long as the entire season's precipitation does not come at once and is not turned immediately into stream flow. It is the watershed vegetation that slows down the runoff to make storage less extensive and expensive, and that makes long-continued percolation to underground storage possible. Second, the gunited or tin-roof type of watershed has not proved desirable. Residents of the desert areas of California and along the Wasatch front in Utah have suffered severe floods from denuded watersheds. In many cases the affected communities have gone to great effort and expense to get a cover vegetation re-established. As the cover has come back, flood damage has been reduced.

Research findings show that, though vegetation does take its toll of the water supply in arid regions, the residual water is almost all usable. Where the vegetation is gone, stream runoff often becomes flood flow. Such a flow is usually entirely wasted, except for percolation underground, and, in any event, is contaminated with a heavy load of silt and debris at nearly all stages. Interested Californians might well review the watershed studies carried on by the Forest Service at the San Dimas Experimental Forest near Los Angeles.

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Antigen Films and Long-Range Forces

In a recent note (*Science*, July 30, 1948, pp. 107–108) Karush and Siegel produce evidence from electron microscope studies of deposited protein monolayers that the monolayers on glass slides are not smooth layers of uniform thickness. The protein layers are apparently irregular in thickness with ridges or peaks which, in extreme cases, may be as high as 200 A. They assume from this that when multilayers of barium stearate are deposited on this irregular monolayer, the ridges or peaks project *through* the barium stearate layers. On the basis of this assumption they challenge the necessity for specific long-range forces as postulated by Rothen (*Science*, November 2, 1945, p. 446; *J. biol. Chem.*, 1947, 168, 75) to explain the specific interaction of an antibody with the antigen layer, through the intervening layers of barium stearate.

There is no apparent justification for this assumption of Karush and Siegel. On the contrary, it seems unlikely that the peaks of the protein layer will project through any monolayer deposited on it. It is well known that, when monolayers are deposited onto a solid plate from a liquid surface, the deposition ratio is almost exactly unity (cf. Langmuir, *et al. J. Amer. chem. Soc.*, 1937, 59, 1751). This is true if the "solid plate" is a fine wire gauze so that the monolayer does not even follow the contours of macroscopic irregularities on the plate surface. The film is stretched across the tops of any peaks or ridges.

Karush and Siegel observed ridges which were generally between 50 and 85 A high, and there is therefore no reason to suppose that these would have any effect on a monolayer deposited on the protein film. If the protein film is ridged, it means that the bulk of the protein will be even farther away from the antibody than is indicated by the thickness of the "barrier" layer.

If the explanation of Rothen's results is to be found in some penetration of the barrier by antibody or antigen molecules, then a more probable mechanism could be provided by the crystallization of the barrier layers. Multilayers usually form microcrystals which are continuous through the thickness of the multilayer, and so there will be intercrystalline boundaries extending from top to bottom. It is conceivable that one or more active groups of the antibody could penetrate at one of these boundaries. It does not seem necessary for the initial "hole" in the barrier to be large enough for a complete antibody molecule to get through. If a particularly active group can approach near enough to the antigen, it is possible that the forces brought into play are large enough to extend the "hole" so that a considerable amount of antibody could then penetrate the barrier.

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Precedence of Modern Plant Names Over Names Based on Fossils?

James M. Schopf has proposed an amendment to the International Rules of Botanical Nomenclature to the effect that names based on recent material should always take nomenclatural precedence over names based on fossil or subfossil specimens (*Science*, April 2, 1948, pp. 344–345). "Always," in this connection, obviously means even that the law of priority may thereby be violated. In *Science* (October 29, 1948, p. 483) the author reports a "generally favorable" reception of his proposal.

Both proposal and reception seem deplorable from a strictly nomenclatural point of view. They seem to be based on the "natural but mistaken assumption that types are somehow typical, that is, characteristic of the groups in which they are placed," and on the fact that "types . . . are by many students supposed to be not only name-bearers but also the bases on which group concepts are erected and the standards of comparison for those concepts" (Simpson. *Bull. Amer. Mus. nat. Hist.*, 1945, 85, 29). The primary and only function of types, however, is name-bearing; this makes strict adherence to the law of priority imperative. Therefore, substitution of a new type species of a genus for an already established one, as suggested by Schopf, e.g. in the case of *Metasequoia*, is not only not permissible under existing rules[1] —as he agrees—but even if it were to be permitted by an amendment, it would be bound to create confusion.

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Unconsciously Schopf, himself, gives an example of such confusion (p. 483): Should the living and the fossil *Metasequoia* prove to be really congeneric—a fact not yet established beyond doubt, according to the author—and should, furthermore, his above proposal be accepted and incorporated in the Rules, then, he suggests, the genus "should be cited for type reference as *Metasequoia* Hu and Cheng, *non* Miki." However, such a way of citing has always implied, and obviously still implies, that Hu and Cheng (the authors of the living *Metasequoia*), on the one hand, and Miki (the creator of the genus *Metasequoia*, based on a fossil species), on the other, applied the same name to two different genera, whereas in the present case the species to which both authors apply this generic name are congeneric, according to Schopf's own premise. Thus, the same name means also the same thing. It would seem that no better *reductio ad absurdum* could be thought of for Dr. Schopf's proposal.

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The Human Engineering Seminar at New York University

Readers of *Science* are likely to be interested in learning about a pioneering effort in the cross-fertilization of ideas from many scientific fields which is currently being made in the College of Engineering, New York University. The present Seminar in Human Engineering, which is a continuation of a more informal series of sessions held during the spring of 1948, is sponsored jointly by the College of Engineering and the Institute of Industrial Medicine of the College of Medicine.

Human engineering, as conceived by the seminar participants, is a rapidly expanding branch of applied science which is concerned with the general problems of the interactions of men and machines. The emerging science of human engineering, which others have referred to as biomechanics, biotechnology, and psychophysical systems research, draws heavily upon the experimental techniques and data of engineering, the biological sciences, the medical sciences, psychology, and certain of the social sciences, notably anthropology, all of which are concerned with the conditions under which man works and the factors associated with optimal performance with machines.

Sessions of the Human Engineering Seminar have attracted representatives from virtually all of the the professions whose mutual interests find expression in the seminar. Each session, although devoted to a consideration of a limited segment of the field of human engineering, has proved useful to various professionals in attendance in suggesting ways in which the data and principles from another science can be applied to the study and evaluation of problems in their area. Among those attending the meetings there has developed a deepened appreciation for the cross-disciplinary approach which characterizes the papers presented, and this appreciation is grounded in the experience of learning to think within the framework of an often alien point of view.

As a result of a number of seminar sessions, the major problems and issues of human engineering have begun to emerge and to clarify themselves, and there is a growing acceptance among participants of the need to fashion practical working procedures for the team approach to the resolution of pressing research problems from many sciences which find concrete expression in this field.

To indicate the trend of thinking among seminar members, it is useful to glance at the broad areas which have been considered. Arthur Lefford, of the College of Engineering, presented a psychological approach to "The Present Status of Fatigue," in which there was a serious effort to understand problems of fatigue within the context of motivation as a psychological process. "An Over-All View of Personality for the Human Engineering" sought to advance the notion that in human engineering research man has for too long been considered either a machine or machine-like, and that it is time now to concern ourselves with the attitudes, motivations, and other personality characteristics and processes of men in relation to the design and operation of machines.

The session on "Environmental Factors in Human Engineering," led by Norton Nelson, of the College of Medicine, New York University, sought to present facts and principles from physiology which have a direct bearing upon human engineering research inquiries. Although devoted to certain selected problems in the thermodynamics of human behavior, the presentation suggested clearly the broad values of the physiological approach to human engineering. Matthew Luckiesh, of the General Electric Lighting Research Laboratory, in his paper, "The Human Seeing Machine," sought to make clear the enormous number of problems confronting the illumination engineer in a consideration of even the simplest human engineering inquiry in the area of illumination.

Other papers on "The Present Status of Principles of Motion Economy" and "Anthropometric Data in the Design and Operation of Machines and Equipment" highlight other interests of seminar members. These and other papers presented before the Human Engineering Seminar have been informally published as "Contributions to Human Engineering" and are already finding use in the work of those who ally themselves and their research with the human engineering point of view which the Seminar has sought so earnestly to develop.

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[1] Analogy with neotypes for species whose original type has been lost or destroyed would not be justified, even if the situation were similar, which it is not; for the types of species are physical specimens, but those of genera are species, which are mental concepts.

In Memoriam

Richard Chace Tolman

1881-1948

Richard Chace Tolman, professor of physical chemistry and mathematical physics at the California Institute of Technology and dean of the Institute's Graduate School from 1934 to 1946, died September 5, 1948, in Huntington Memorial Hospital, Pasadena, at the age of 67 years, from pneumonia following a stroke which he had suffered on August 14. For more than a quarter-century one of the great leaders in the intellectual life of the California Institute, for more than a decade at different times scientific agent or adviser to the Government in critical problems, Dr. Tolman was, through the comprehensive versatility of his mind, not merely an expert student of relativity, thermodynamics, and other equally abstruse fields, but a theoretician of the structure of the universe the breadth and acumen of whose concepts had led to his being numbered among the world's greatest cosmologists.

He was born in West Newton, Massachusetts, March 4, 1881, and took his B.S. degree in chemical engineering from the Massachusetts Institute of Technology in 1903. The following year he spent in Germany, part at the Technische Hochschule at Charlottenburg, Berlin, and part in an industrial chemistry laboratory at Crefeld. Returning for graduate study at the Massachusetts institution, he served as research associate in theoretical chemistry for two years and in physical chemistry for two years thereafter, receiving the doctorate in 1910. After service in chemistry on the faculties of the Universities of Michigan, Cincinnati, and California (Berkeley), he was called to a professorship of physical chemistry at the University of Illinois in 1916.

During the first World War as chief of the Dispersoid Section of the Chemical Warfare Service, and after the war as associate director and director of the War Department's Fixed Nitrogen Research Laboratory, Dr. Tolman made his first participation in scientific affairs for the Government in time of emergency. Of marked importance in its own right, this was significant foreshadowing of the still greater contributions which he was to make years later in even more urgent circumstances.

From his War Department responsibilities Dr. Tolman went to the faculty of the California Institute of Technology in 1922, where for nearly two decades he was to have uninterrupted opportunity for the studies which brought him world prominence in science and for important and creative work in clarifying the interrelations between physics and chemistry, contributing thus to the breaking down of compartmentalization and to the consolidating of knowledge. Completing at the California Institute the elegant solution of the problem of experimentally measuring the inertia or mass of the electron which he had begun at Berkeley, he went on to a wide range of work in statistical mechanics, relativistic thermodynamics, and cosmology. In all these fields his contributions were of fundamental and lasting significance, as is well exemplified by his classic *The principles of statistical mechanics,* which appeared in 1938.

This period of rich productivity was not permitted to continue; in June 1940, foreseeing the crisis that lay ahead for the United States, Dr. Tolman came to Washington to offer his services to his country. For the next six years he was to have a primary responsibility in the joined efforts of science, industry, and the military which were essential to, and successful in, preserving the free way of life. He served as vice-chairman of the National Defense Research Committee from its inception and had special cognizance of problems of armor and ordnance. He played a very important role in the early inspiration that led to development of the proximity fuse and of rockets. Throughout the arduous and complex undertakings which led to the development of atomic bombs, his knowledge and acumen were of the first order of importance. Not only did he serve as scientific adviser to Gen. Groves from the establishment of the Manhattan District and as U. S. adviser to the wartime Combined Policy Committee, but once the bombs resulting therefrom had put an end to the war, he became chief technical adviser to Mr. Baruch, U. S. representative to the United Nations Atomic Energy Commission, in its endeavors to develop sound means for control of the weapon and development of the peaceful uses of atomic energy. In these exacting assignments he was in the highest sense a scientist-statesman. The U. S. Medal for Merit and the rank of honorary Officer of the Order of the British Empire came to him in recognition of that fact.

Of profound scholarship and unsparing intellectual rigor, Richard Tolman was, in addition, a man of great wisdom and personal kindliness. Outstanding as was his ability in research, it was more than equaled by his skill in teaching, and that, as always, was owed to wisdom and kindliness. In his own being he combined the ethical insight and scientific intelligence on which, taken together, he based his faith, declared at Brown University in 1947, "that the control of evil is possible. I am sure," he said in that address, "that humanity will continue to encounter great troubles, but I do not think that civilization will destroy itself. To surmount our troubles, we shall need courage, and patience, and clarity of thought, and sincerity in the advocacy of fair and reasonable courses of action. For these virtues we may pray, each in his own fashion."

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Book Reviews

Cancer, I, Hérédité, hormones, substances cancérigenès. J. Maisin. Paris: Casterman, Tournai-Paris, 1948. Pp. 248. 84 fr.

In the Introduction the author states that he has written this book for intellectuals not specialized in the cancer problem, although he hopes that the physician and even the cancerologist may draw some benefit from reading it. This statement alone suffices to explain the high qualities of the book. For if an intellectual from a field writes for another intellectual from another field, he will, naturally, maintain his subject on a plane high enough while avoiding tedious detail and an excess of technicalities. On the other hand, since he can rely on the receptiveness of mind of his reader and his general background, he will try to go to the essence of the facts and the biological problems therein involved. By doing so, these problems detach themselves from the strict branch of science from which they have emerged and become universal biological problems. Dr. Maisin has fully succeeded in making himself understood by another intellectual, and his hope of capturing the interest of the specialist has been fulfilled.

Whatever should be known of the work done on cancer in order to understand future developments is succinctly given in the first pages of the book together with pertinent historical data. The author then goes into a complete survey of the three main subjects of this volume: the relation of cancer to, first, heredity; second, hormones; and third, certain chemical substances called carcinogens. This he does brilliantly.

We are all aware of the appalling number of significant contributions to these subjects during the last 20 years. All of them are reviewed by the author, and the references are appended in an orderly fashion. The author does not list these coldly, leaving to the reader the task of drawing his own conclusions on the basis of the raw material displayed. The reader is constantly helped in this task by the author, who selects the facts, uses the right adjectives to qualify them, and often gives his own opinions on the problems, to many of which the School of Louvain has actively contributed.

One notes in the book the predominance of American literature, especially during the last 8 or 10 years. Interesting contributions from Europe have appeared, however, even during the war, and those from France and Belgium are not generally known among American cancerologists. Inclusion of these still further enhances the value of the book.

In several ways Maisin's book reminds one of that written by Charles Oberling and published in 1942. This book, which was translated into English, has been avidly read and has had a decided influence on many minds. The same should be done with Maisin's book following publication of the second volume.

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Outlines of physical chemistry. Farrington Daniels. New York: John Wiley; London: Chapman & Hall, 1948. Pp. viii + 713. (Illustrated). $5.00.

As Prof. Daniels states in his preface, *Outlines of physical chemistry* is to be regarded as the first edition of a new book. The high standards set by Getman and by Getman and Daniels in their previous well-known and widely used texts on physical chemistry have been maintained, but progress in research in physical chemistry required a rewriting rather than merely a revision.

The author's point of view is perhaps best presented by quoting a statement from the introductory chapter: "Usually science progresses by inductive reasoning from a few facts, follows with deductive reasoning based on the hypotheses, and, finally, tests by experimental measurements designed to prove or disprove the theoretical deduction. Many hypotheses are destined to be discarded when new facts and more precise data are obtained, but they fulfil a very necessary function in the development of science. A successful hypothesis is not necessarily a permanent hypothesis, but it is one which stimulates additional research, opens up new fields, or explains and coordinates previously unrelated facts. The scientist needs imagination in creating new hypotheses, but he needs also ingenuity and skill in devising experiments to test them and critical judgment in evaluating the results."

The general field of physical chemistry is covered quite completely, and it seems pointless to list the titles of the chapters. It should, however, be mentioned that in addition to the traditional topics, excellent chapters on colloids, quantum theory, photochemistry, and nucleonics are included. Emphasis is placed on the structure of matter, and not until this fundamental groundwork has been treated is the student exposed to the more abstract thermodynamic development of the subject. Practically all the necessary mathematical derivations are given in detail in the text; only a few are relegated to an appendix for the ambitious student. The annoying tendency of many writers to overwork the phrases "it can be shown" and "obviously" does not appear.

One of the best features of this text, from the pedagogical point of view, is the liberal use of numerical examples and problems. Furthermore, these are not hypothetical cases which fail to give the student any contact with reality, but are mainly based on actual data from the literature. It is the sort of training which will best prepare the student for research work later. These problems cover the whole range of practical work from calculation of atomic weights from gas densities to determination of the rate of transmutation in an atomic pile. Another commendable feature of the book is the bibliography: references to up-to-date literature are given, and, in addition, each chapter concludes with a series of cross-references to other books for supplementary reading. It is a pleasure to recommend *Outlines of physical chemistry*, and Prof. Daniels is to be congratulated for a fine piece of work.

RAYMOND M. FUOSS

Yale University

North American trees (exclusive of Mexico and tropical United States). Richard J. Preston, Jr. Ames, Ia.: Iowa State College Press, 1948. Pp. lv + 371. (Illustrated.) $4.00.

Setting as his triple target the nontechnical public, students, and scientists, the author should be credited with a near miss. For the nontechnical public and for beginning students of dendrology, this compilation of illustrations and almost telegraphic descriptions of the important trees of the United States and Canada should prove very helpful. Certainly, it will save the time of those who, in the past, have had to consult five or six important works for various geographic regions. But the scientist will wish to digest for himself the authoritative source material which the author has assimilated but failed to cite in any list of references in this volume.

Eleven pages, packed full of technical terminology and diagrams, are devoted to a *nontechnical* explanation of the "Natural Relationship of Trees" and to descriptions of the "Forest Regions of North America" and "Tree Characters." Had the frontispiece map been slightly modified to coincide with the groupings of the forest regions in the text, this subject of regions and forest types would have been even more useful.

The Keys to the Genera—the keys to the species of the genera among the gymnosperms and to those of the genera among the angiosperms—will, with the liberal use of the 9-page glossary, prove very useful indeed. However, the chief value of the book would seem to lie in the compact presentation of drawings of foliage, twig, bud, fruit, and seed characteristics in a form convenient to take into the field for direct comparison. The small distribution maps are also helpful.

The volume is recommended to those who are frequently plagued with the question: "What's that tree?"

M. A. HUBERMAN

Food and Agricultural Organization of the United Nations, Washington, D. C.

Scientific Book Register

COURANT, R., and FRIEDRICHS, K. O. *Supersonic flow and shock waves.* New York-London: Interscience, 1948. Pp. xvi + 464. (Illustrated.) $7.00.

HARRISON, GEORGE R., LORD, RICHARD C., and LOOFBOUROW, JOHN R. *Practical spectroscopy.* New York: Prentice-Hall, 1948. Pp. xiv + 605. (Illustrated.) $6.65.

MAYER, CLAUDIUS F. (Ed.) *Index-catalogue of the library of the Surgeon General's office, United States Army (Army Medical Library).* (Fourth Series, Vol. X, M-Mez.) Washington, D. C.: Superintendent of Documents, U. S. Govt. Printing Office, 1948. Pp. iv + 994. $4.25 (cloth).

POLLARD, ERNEST C., and STURTEVANT, JULIAN M. *Microwaves and radar electronics.* New York: John Wiley; London: Chapman & Hall, 1948. Pp. vii + 426. (Illustrated.) $5.00.

SCHMIDT, ALOIS X., and MARLIES, CHARLES A. *Principles of high-polymer theory and practice.* New York-London: McGraw-Hill, 1948. Pp. xii + 743. (Illustrated.) $7.50.

SEWELL, R. B. SEYMOUR. *The free-swimming planktonic Copepoda: geographical distribution.* (The John Murray Expedition, 1933–34; Sci. Rep., Vol. VIII, No. 3.) London: British Museum (Natural History), 1948. Pp. 318–592. (Illustrated.) 35/–.

SMITH, AUSTIN, and HERRICK, ARTHUR D. (Eds.) *Drug research and development.* New York: Revere, 1948. Pp. xi + 596. $10.00.

(Continued from page 10.)

agreement of our findings with the predicted theory of the ultrastructure of the chromosome. The unit particles observed by us were associated with individual chromonemata. Although the particles varied in shape and size from one band to another, they had a uniform character in any one band. Their size range and density make them comparable with virus and bacteriophage particles. They are identifiable with the substance of chromomeres well known to the light microscopist. There is no doubt but that this is nucleoprotein. In view of these conclusions, it seems reasonable to believe that the discrete particles we have seen are genes.

NEWS and Notes

Marshall Brucer, assistant professor of physiology at the University of Texas School of Medicine, has been selected to direct the cancer research program of the Oak Ridge Institute of Nuclear Studies. In his new position as chairman of the Medical Division Dr. Brucer will direct a long-range program devoted to the study of the treatment of cancer and other malignant diseases, together with the training of medical and research personnel in new techniques.

Marston Taylor Bogert, professor emeritus of organic chemistry, Columbia University, and consultant and adviser to Evans Research and Development Corporation of New York City, has been appointed Charles Frederick Chandler lecturer and medalist at Columbia for the current academic year.

Frank W. Schaller, formerly associate professor of agronomy at West Virginia University, became research associate professor at Iowa State College on January 1.

Leonard F. Kellogg joined the Iowa State College faculty as professor of forestry January 1. He has been silviculturist at the Central States Forest Experiment Station, assigned to the College.

Ira A. Gould, professor of dairy manufacturing at the University of Maryland, has been appointed chairman of the Department of Dairy Technology at Ohio State University, effective February 1.

Henry W. Meyerding, professor of orthopedic surgery at the Mayo Clinic and president-elect of the U. S. Chapter of the International College of Surgeons, recently returned from Europe. While abroad he presided at the Fourth Congress of the International Society of Orthopedic Surgery and Traumatology in Amsterdam and also took part in the program. Later he gave the opening address at the Congress of the Czechoslovak Society of Orthopedic Surgery and Traumatology in Prague and was made an honorary member of that Society. He then attended meetings of the French Society of Orthopedic Surgery and Traumatology and the French Society of Surgery in Paris, where he was made an honorary member of the latter Society. Honorary membership in the Netherlands Orthopedic Association was also extended to him at a congress held in Amsterdam this year.

John W. Gowen has been named head of the Genetics Department at Iowa State College. Dr. Gowen, associated with Iowa State since 1937, succeeds **E. W. Lindstrom**, who died November 8.

O. Hobart Mowrer, research professor of psychology in the University of Illinois Graduate College, was recently appointed to the newly created post of director of the Psychological Clinic.

Edwin J. Cohn, chairman of the Department of Physical Chemistry, Harvard Medical School, has been chosen to deliver the Julius Stieglitz Memorial Lecture for 1949 at the forthcoming meeting of the Chicago Section of the American Chemical Society in the University of Chicago Kent Chemical Laboratory on Friday, January 14, at 8 P.M. Dr. Cohn will speak on ''Interactions of Proteins With Each Other, With Cells, and With Smaller Molecular Components of Biological Systems.''

Walter J. Peterson became head of the Chemistry Department, North Carolina State College, on January 1. Dr. Peterson, former head of the Nutrition Section of the Animal Husbandry Department, succeeds **Arthur J. Wilson**, who died November 11.

Warren Ambrose, Norman Levinson, and **Henry Wallman**, of the Mathematics Department, Massachusetts Institute of Technology, are at present on leave of absence. Prof. Ambrose, who is at the Institute for Advanced Study, and Prof. Levinson, who is at the University of Copenhagen, are both working under Guggenheim fellowships; Prof. Wallman, meanwhile, is acting as visiting professor of teletechnics at the Chalmers Institute of Technology in Gothenburg, Sweden.

W. D. Cairns, professor emeritus of mathematics at Oberlin College, is serving as part-time lecturer in mathematics at the California Institute of Technology for the present academic year.

Emil Witschi, who is on leave from the Department of Zoology, State University of Iowa, and is at present working at the University of Tübingen, has been made an honorary member of the Société d'Endocrinologie de Paris.

Visitors to U. S.

B. R. Seth, of Hindu College, Delhi, India, will be serving as visiting professor of applied mathematics at Iowa State College during the current year and will give courses in elasticity and hydrodynamics in the winter and spring quarters.

W. H. J. Fuchs, of the University of Liverpool, is serving as visiting associate professor of mathematics at Cornell University for the current academic year.

Awards

The John Scott Award, established by the Scotch chemist of the same name who died in 1816, to be awarded to ''ingenious men and women who make useful inventions,'' was conferred December 15, at Girard College, Philadelphia, on Merle A. Tuve, director of the Department of Terrestrial Magnetism, Carnegie Institution of Washington. Dr. Tuve was named to receive the award for his outstanding contribution to the development of the proximity fuse during World War II. Former recipients of the award, which is usually in the amount of $1,000, include Madame Curie, Thomas Edison, Guglielmo Marconi, Lee DeForest, and Irving Langmuir.

Carl S. Miner, founder and director of the Miner Laboratories, Chicago, has been awarded the 1949 Perkin Medal of the American Section, Society of Chemical Industry, for the work of his laboratory in developing the furfural industry. Furfural, a chemical derivative of oat hulls and other agricultural wastes, is widely used in the manufacture of plastics. Mr. Miner will receive the Medal January 7 at a dinner at the Hotel Commodore, New York, jointly sponsored by the Society of Chemical Industry, the New York Section of the American Chemical Society, the American Institute of Chemical Engineers, and the Electrochemical Society. His address, as the 43rd medallist, will be ''Science vs. Starvation.''

W. L. Waterhouse, University of Sydney, has been awarded the 1949 Medal of the Federal Council of the Australian Institute of Agricultural Science for his service to Australian agriculture during the past 10 years.

Fellowships

The RCA Predoctoral Fellowships in Electronics are designed to give special graduate training and experience to young men and women who have demonstrated marked ability in the general field of electronics, either as a branch of electrical engineering or as a part of the general field of physics.

A Fellow must be a citizen of the United States who has demonstrated ability and aptitude for advanced work and who has training in electronics equivalent to that represented by one year beyond the bachelor's degree in a university of recognized merit in this field.

Fellowships will be awarded at a regular meeting of the RCA Fellowship Board to be held in March 1949. To receive consideration for tenure during the academic year 1949–50, applications must be filed on or before *February 1*, 1949. Unless otherwise arranged, tenure will begin in September 1949.

The National Foundation for Infantile Paralysis, 120 Broadway, New York City 5, has announced the availability of a limited number of postgraduate fellowships in several fields. These include: (1) research fellowships, to be awarded in virology, orthopedic surgery, pediatrics, epidemiology, and neurology, which are intended to emphasize advanced training in the basic sciences as they apply to the particular specialty and to research, and experience in research not necessarily related to poliomyelitis; (2) clinical fellowships, which are available to physicians who wish to prepare for eligibility for certification by the American Board of Physical Medicine; and (3) fellowships, which are available to physicians for one year of postgraduate study leading to a Master of Public Health degree at a school of public health approved by the American Public Health Association.

Application and requests for further information may be made to the National Foundation at any time during the year. Awards are based on the individual needs of each applicant.

A project for the study of the fundamental principles of flameproofing has been established in the Department of Chemical Engineering, Columbia University, New York, jointly by the Textile Section of the Quartermaster Corps and the Office of Naval Research. During World War II a similar war research project, under the sponsorship of the Quartermaster Corps, was maintained at Columbia for a study of improved methods for flameproofing and, as a result of some of the work of the earlier project, it has been decided to make a more thorough investigation of the various mechanisms whereby certain fire-retardant chemicals prevent the combustion of cellulose and other types of textile fibers.

Two positions as research assistants are available in the Department of Chemical Engineering under this project. These will permit credit for the researches under the project to be acceptable for the requirements of the Ph.D. degree. The research assistantships, which are open to qualified applicants who possess a Master's degree in chemical engineering or chemistry, carry a salary of $200 per month for a 40-hour week. This would permit part-time course study in conjunction with the work of the project in order to meet the course requirements for the Ph.D. degree. Applicants interested in appointment as research assistants under the project should communicate with Prof. James M. Church, of the Department of Chemical Engineering, who is in charge of the project, stating fully their qualifications as to training and experience.

Colleges and Universities

The M. W. Welch and R. E. Welch Science Teachers Workshop at Purdue University will be dedicated in ceremonies to be held in the Physics Building January 8. Karl Lark-Horovitz, head of the Physics Department, will introduce C. H. Robertson, of the physics staff, who will speak on ''The Experiment in the Teacher Training Program.'' Following a dinner in the Purdue Memorial Union, Louis M. Stark, manager of the School Service department of Westinghouse Electric Corporation, will give an address entitled ''The Enrichment of Science Instruction.''

Carnegie Institute of Technology has announced the reopening of a $4,000,000 campus building and renovation program. A $1,000,000 wing will be built onto Engineering Hall, and over $1,000,000 will be spent on a power plant and a steam and electricity distribution system. In addition, there will be extensive revamping and renovation of available space in existing buildings of the Colleges of Engineering and Science, Fine Arts, and Margaret Morrison Carnegie College. In announcing the program, President Doherty stated that not a single building had been added to the campus since completion of the original plant in the early 1900s.

Meetings and Elections

A Conference on High-Frequency Measurements will be held January 10–12 in Washington, D. C., under the joint sponsorship of the American Institute of Electrical Engineers, the Institute of Radio Engineers, and the National Bureau of Standards. In addition to tours of the Naval Research Laboratory, the Naval Ordnance Laboratory, and the National Bureau of Standards, the program will include four technical sessions—''Measurement of Frequency''; ''Measurement of Power and Attenuation''; ''Measurement of Impedance''; and ''Measurement of Noise, Antenna Measurements.'' The auditorium of the Department of Interior has been made available for these meetings. Those planning to attend the sessions must register Monday morning, January 10, at the Roger Smith Hotel, headquarters for the conference. Chairman of Local Arrangements is Harold Lyons, National Bureau of Standards, Washington D. C.

The American Society of General Physiologists is holding its next regional meeting on February 5 at New York University, Washington Square, under the auspices of the Biology Department of the Graduate School. The main speakers will be Keith Porter and Parker Vanamee, Robert Chambers, Harold Blum, Eric Ponder, Curt Stern and Alexander Sandow, and Arthur J. Kahn, and all the papers will deal with cell structure and function.

A Symposium on Molecular Structure and Spectroscopy will be held at the Mendenhall Laboratory of Physics, Ohio State University, June 13 through June 17, 1949. The interpretation of molecular spectroscopic data as well as methods for obtaining such data will be discussed, and there will also be sessions devoted to those phases of spectroscopy of current interest. A dormitory will be available for those who wish to reside on the campus during the meeting. Further information and copies of the program when they become available may be obtained by writing to Prof. Harald H. Nielsen, Mendenhall Laboratory of Physics, Ohio State University, Columbus 10, Ohio.

At the 286th anniversary meeting of the Royal Society, held November 30, the following officers and members of the Council were elected for the ensuing year: Sir Robert Robinson, president; Sir Thomas Merton, treasurer; Sir Edward Salisbury and D. Brunt, secretaries; E. D. Adrian, foreign secretary; J. D. Bernal, G. R. Cameron, Sir James Chadwick, S. Chapman, H. Davenport, Sir Frank Engledow, W. E. Garner, A. C. Hardy, C. H. Kellaway, G. F. Marrian, Sir William Stanier, H. G. Thornton, C. E. Tilley, A. E. Trueman, and S. Zuckerman, members of the Council. Sir Alfred Egerton, having completed 10 years as physical secretary, is succeeded by D. Brunt.

A Symposium on the Quantum Requirement in Photosynthesis was held December 18 on the University of Illinois campus. Oswald Tippo, chairman of the Department of Botany, reports that the participants included Farrington Daniels, of the Department of Chemistry, University of Wisconsin; J. F. Stauffer, of Wisconsin's Department of Botany; Otto H. Warburg, director of the Kaiser Wilhelm Institute of Cell Physiology, Berlin, and now visiting professor at Illinois; R. Rieke, Department of Physics, Purdue University; Barry Commoner, Department of Botany, Washington University, St. Louis; Martin Kamen, Institute of Radiology, Washington University; C. S. French, director, Carnegie Institution Laboratory of Biology, Stanford, California; Allan H. Brown and A. W. Frenkel, Department of Botany, University of Minnesota; Hans Gaffron, Department of Chemistry, University of Chicago; and Robert Emerson, Eugene Rabinowitch, and Victor Schocken, of the Photosynthesis Project, Department of Botany, University of Illinois. This symposium was arranged to discuss the discrepancies which have been reported in the quantum requirement of photosynthesis. According to Dr. Tippo, Dr. Warburg has found that 4 quanta are required, while Prof. Emerson and other American workers find that 10–12 quanta are required.

The symposium was followed by a series of critical experiments performed by Drs. Warburg and Emerson during the Christmas holidays. Dean Burke, National Cancer Institute, Bethesda, Maryland, and J. Z. Hearon, Department of Physiology, University of Chicago, were invited to the campus as scientific observers.

The Technical and Scientific Book Publishers Group of the American Book Publishers Council, Inc., at an informal meeting in New York City on December 1, unanimously re-elected the following officers: Francis M. Turner, Reinhold Publishing Corporation, chairman; Maurits Dekker, Interscience Publishers, Inc., vice-chairman; and Ralph L. Newing, International Textbook Company, secretary.

NRC News

The needs of the American Type Culture Collection is the subject of a study being made by a Committee of the National Research Council. The ATCC maintains pure "type" cultures of many microorganisms and furnishes these to laboratories, hospitals, universities, and industries. With a limited income inadequate for its maintenance at the present time, the ATCC has been faced with the prospect of discontinuing or greatly restricting its functions and services. The new NRC Committee will attempt to develop a long-range plan for the support of the Collection on a permanent basis. The membership of the Committee is as follows: Henry Welch, chairman; Robert D. Coghill, George W. Irving, Kenneth B. Raper, Roger D. Reid, Waldo L. Schmitt, Joseph Smadel, Nathan R. Smith, and Norman H. Topping.

Meanwhile, there is urgent need for support of the ATCC for the year 1949 from organizations and individuals who are aware of the necessity of pure type cultures in the standardization of products, in research, and in teaching. Contributions to the ATCC may be sent to the National Research Council, National Academy of Sciences Building, 2101 Constitution Avenue, N. W., Washington 25, D. C., for use at the direction of the NRC Committee.

Deaths

Carl V. Woodbury, 71, professor and head of the Physics Department, Norwich University, died December 13 in Northfield, Vermont. A Norwich faculty member for nearly 50 years, Dr. Woodbury had at one time also served as acting president.

Victor Kuhr, 66, professor of philosophy at the University of Copenhagen, died December 15 in Copenhagen, Denmark.

John Franklin Daniel, 3rd, 38, professor of practical archaeology at the University of Pennsylvania and editor-in-chief of the *American Journal of Archaeology,* died of a heart attack December 17 at Ankara, Turkey.

Philip S. Winnek, 40, head of the Chemotherapeutic Research Department of the Maltine Company, Morris Plains, died in Morristown Memorial Hospital, Morristown, New Jersey, on December 18. As a former research chemist for the American Cyanamid Company, Dr. Winnek played a large part in developing the drugs sulfadiazine and sulfaguanidine.

Hugh Scott Cumming, 79, retired Surgeon General of the U. S. Public Health Service, died December 20 in Washington, D. C. Of the more than 40 years that Dr. Cumming was associated with public health work, he served as Surgeon General for 16 and directed the Service's growth from a comparatively unknown section of the Treasury Department to a bureau employing over 1,000 physicians. Recipient of many foreign honors, Dr. Cumming had also served as president of the Pan-American Sanitary Bureau.

Frank M. Huntoon, 67, author and former bacteriologist at the Cornell University Medical College, died December 21 in Syracuse, New York.

The American Museum of Natural History has just announced the return of the first major American expedition to remote Cape York Peninsula in Australia. This 1948 Archbold Cape York Expedition was sponsored by Richard Archbold, research associate of the Museum. Extensive and significant collections of mammals, plants, reptiles, and insects were made during the 7 months spent in the field. Among the 1,500 mammal specimens representing more than 50 species are bizarre spiny anteaters, unusual "flying mice," and a specimen of the elusive Bennet's tree-climbing kangaroo. Also included in the collections are 11,600 specimens of plants which are believed to be the first representative collection of plants of far northern Australia ever brought to this country.

A new scientific journal, aimed to provide southeastern engineers and scientists with their own medium for attacking common problems and recording research results, is to appear in January. Recording technological progress in 11 southeastern states, *The Journal of Southeastern Research* will be edited by H. McKinley Conway, Jr., according to the announcements from the Southeastern Research Institute, Inc., Atlanta, Georgia. Serving on the Advisory Board will be Dean O. V. Adams, Texas Technological College; Luis H. Bartlett, director, Engineering Experiment Station, Louisiana State University; J. W. Beams, chairman, Physics Department, University of Virginia; Dean George W. Branigan, University of Arkansas; J. H. Coulliette, director, Industrial Research Institute, University of Chattanooga; Dean Paul M. Gross, Duke University; Albert H. Holland, Jr., director of research and medicine, Oak Ridge National Laboratory; Dean Roger P. McCutcheon, Tulane University; E. B. Norris,-director, Engineering Experiment Station, Virginia Polytechnic Institute; J. Stanton Pierce, head, Chemistry Department, University of Richmond; Wm. G. Pollard, director, Oak Ridge Institute for Nuclear Studies; Herman M. Roth, chief, Physics Research Division, Oak Ridge National Laboratory; Walter M. Scott, director, U. S. Department of Agriculture Southern Regional Research Laboratory; and Wm. G. Van Note, director, Engineering Experiment Station, North Carolina State College.

A history of the development of radar, prepared by the Office of Scientific Research and Development, under the direction of Henry E. Guerlac, now of Cornell University, is available to the public, according to a recent announcement by John C. Green, director of the Office of Technical Services, Department of Commerce. The 1,300-page *History of radar* in four parts may be inspected at the Library of Congress, Government Publication Room, and photostatic or microfilm copies may be obtained from the Library. The four parts, with prices for photostatic and microfilm copies, respectively, are: PB 93618, $53.75, $9.00; PB 93619, $55.00, $9.00; PB 93620, $43.75, $9.00; and PB 93621, $13.75, $4.50.

Establishment of a radioisotope unit has just been authorized by the Veterans Administration at the VA Hospital in Nashville, Tennessee. Research work planned at Nashville will be directed toward developing improved methods for clinical diagnosis and medical treatment of veteran-patients. Radiophosphorus, -sodium, -iron, and -iodine will be used initially in the work. George R. Meneely, assistant chief of medical services at the Hospital, who has had wide experience with the use of radioisotopes, will direct the work of the unit.

Brookhaven National Laboratory has announced the availability of reports on the Symposium on Radioiodine (BNL–C–5), held July 26–30, 1948, and the Conference on the Chemical Effects of Nuclear Transformations (BNL–C–7), held August 19–20, at prices of $1.50 and $.25, respectively. Checks or money orders should be made payable to Brookhaven National Laboratory, and requests should be directed to the Information Group, Information and Publications Division of the Laboratory, Upton, New York.

Correction: In "Radiocardiography: A New Method for Studying the Blood Flow Through the Chambers of the Heart in Human Beings," by Myron Prinzmetal, et al. (*Science*, September 24, p. 340), credit for the design and construction of apparatus should have been given Dr. Burton F. Miller instead of Dr. Robert Miller (footnote 2).

Make Plans for—

American Physical Society, Division of High-Polymer Physics, January 27–29, Columbia University, New York City.

5th Annual Conference on Protein Metabolism, January 28–29, Rutgers University, New Brunswick, New Jersey.

California Mosquito Control Association, joint conference with American Mosquito Control Association, February 6–9, Claremont Hotel, Oakland, California.

Recently Received—

Nutritional Observatory. Published quarterly and distributed gratis by the H. J. Heinz Company, Pittsburgh 30, Pennsylvania.

The calcium requirement of adults. (Borden's Review of Nutrition Research, Vol. IX, No. 9, November 1948.)

Dyelines and Bylines. An informal pamphlet published monthly by the American Cyanamid Company.

Annual report of the Public Health Research Institute of the City of New York, Inc., July 1, 1947–June 30, 1948.

Monsanto Magazine, December 1948. Published by Monsanto Chemical Company, St. Louis, Missouri.

Social Responsibility

George Brock Chisholm,
Director-General, World Health Organization

IF KURT LEWIN HAD DONE NOTHING ELSE during his too short lifetime but provide the amount of inspiration he did for the psychological study of social issues, his should be judged a highly successful life. Add to that all his influence toward sanity, and the infectiousness of his maturity, understanding, and generous tolerance of human frailties, and we clearly draw the picture of a man, truly a leader in terms appropriate to his time. Kurt Lewin was an explorer and pioneer in fields as beset with pitfalls for the unwary or ill equipped as ever were polar seas or tropical jungles. The reluctance of all of us human beings to know ourselves, the aggressions released by any attempt to help us to know ourselves truly, the antagonisms with which we defend our imbedded original premises, no matter how demonstrably fallacious they may be, are well known to all of us who have learned the lessons of the last half-century of pioneering work in these areas. Still, however, and probably for a long time to come, these human reactions are the great barriers to human progress in those very directions which are of the greatest importance to the whole race. In this area of human evolution there is still great need for unselfish devotion, for dedication to high principles, and even sometimes for a degree of martyrdom.

Kurt Lewin and his co-workers in the United States and in England have begun a process which should eventually contribute greatly to bringing the light of objectivity into the whole field of human relations.

Up until recently, through many generations of development, scientific progress has been almost entirely confined to those fields which would contribute directly to commercial or military advantage in a world functioning on the principle of competitive survival. Only in the last few years has it become clear to the people in all countries who are capable of thinking independently of the hysteria of the media of mass communication that this old method of competitive survival has become synonymous with racial suicide. Under the pressure of the anxiety engendered by this awareness the physical scientists have begun to show signs of developing some social responsibility, and the human scientists, some evidences of concern about the immediacy and importance of world problems of human relations and interhuman communication. The recent International Congress on Mental Health with its main theme of study, "Mental Health and World Citizenship," has been a most encouraging sign of this awakening concern. More than 5,000 people—psychologists, psychiatrists, social anthropologists, sociologists, educators, and others—participated actively in the preparation for that congress, many of them over periods of a year or more. There is no mistaking the urgency of the call which awakened this significant response and brought together in London more than 2,000 people from 54 countries to hear each other's ideas and share their experiences.

These are some of the signs of a changing orientation of science. In the past, science in its purer forms has been content to add to the sum of human knowledge; in its less disinterested preoccupations it has added to the wealth of those who already were in a financial position to subsidize scientific research—theoretically, all to the ultimate advantage of the human race. Only recently have scientists themselves begun to recognize that any increase of knowledge does not at all necessarily work to the advantage of the human race and to be willing, though reluctantly, to accept some responsibility for what is done with the knowledge they uncover. However, other agencies, civil or military, are not generally by any means ready to admit scientists to these sacred areas where business and politics worship the old gods of profit, prestige, and power. Generally, they are not yet ready to see that the exclusion of scientific attitudes from the field of human relations, while employing the full strength of scientific method in the material fields, may well destroy the human race in the not distant future. In spite of this natural reluctance to admit continuing failure and to call for help, and the inevitable defensive disparaging of the scientific attitude at policy levels, it becomes increasingly clear that the designing,

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At meetings of the American Psychological Association, held in Boston in September 1948, the Society for the Psychological Study of Social Issues conferred on Dr. Chisholm its first annual Kurt Lewin Memorial Award. The recipient at that time delivered this Kurt Lewin Memorial Lecture. In introducing the speaker and conferring the award, Donald W. MacKinnon, of the Department of Psychology, University of California, stated that the SPSSI had established the award "to commemorate one who in his researches and in his professional activities exemplified the highest goals of the Society, and to encourage, through a recognition of their outstanding contributions, those who, like Kurt Lewin, in their work develop and integrate psychological research and social action." At the time of his death in February 1947, Dr. Lewin was director of the Research Center for Group Dynamics at the Massachusetts Institute of Technology.

building, and operating of modern civilization requires techniques different from those of a generation ago. The builder of a prairie schooner is not qualified by his experience to design or build a turbo-jet aeroplane, nor could any of his contemporaries fly it. Many of our sociopolitical methods are reminiscent of the prairie schooner and pony express days, though the scientists have ushered in an era of instantaneous world communication, and potential world destruction.

To change the metaphor—our civilization, like a great ship, driven by the enormous power of its scientific development, is rushing on into treacherous and unreliably charted seas. The equipment of our pilots is far short of the best available. Their principles, their instruments, and even their charts are commonly inherited from previous generations and founded on folklore, superstition, faiths inculcated in childhood, prejudice, or even, much worse, on local political advantage. It is a fact that in other fields of governmental responsibility the best available experts are invariably employed to design, construct, and operate, whether it be a dam, a ship, an airplane, agricultural production, atomic bombs, a financial or accounting system, or anything else, except in the field of human relations. There, any kind of person may be used. Commonly lawyers are given these responsibilities; their training is in rules and precedent, one of the worst possible technical trainings for this work. Sometimes soldiers are taken from their normal business to be put in charge of our relations with other peoples; their training is in strategical and tactical maneuvering to gain predetermined ends at the expense of an enemy. The whole military training presupposes an opponent and teaches how to circumvent and defeat him, not how to cooperate with other kinds of people who are often as difficult and as sure they are right as we are ourselves. Clearly, military training is also one of the worst possible for this work. Business men trained to make profits or old-time diplomats trained in gentlemanly behavior and the classics are also obviously inadequate to the needs of interhuman relations on a world scale. It is true that a certain number of economists and sociologists in recent years have been given some work to do in the international field, but usually only as technicians or secretariats, to carry out the orders of governing bodies, and rarely on national and intergovernmental policy levels. Also, the training of sociologists and economists tends to concern itself almost exclusively with the study of human institutions and their functioning, not the study of human beings and their interrelationships.

The situation is illustrated by a glance at the position in just one of the agencies of the United Nations. For instance, while the Constitution of the World Health Organization defines health as "a state of complete physical, mental, and social well-being and not merely the absence of disease or infirmity" and states that "the healthy development of the child is of basic importance" and "the ability to live harmoniously in a changing total environment is essential to such development," at the First World Health Assembly, attended by representatives of some 68 nations, of which 55 are full members, so far as I have been able to find out there were no psychologists, no social anthropologists, and only one neuropsychiatrist included in national delegations totaling about 250. The one neuropsychiatrist was on the delegation of the Ukrainian Soviet Socialist Republic. No other government felt the need of any technical information or advice in the field of mental health or human relations. This is a highly significant and important fact.

Of course, it is not to be taken for granted that any particular type of technical training now being given at any university would be useful specifically in this enormously important field of interhuman relations. The curricula in political science courses seem to be woefully inadequate to these responsibilities, as do those in psychology, psychiatry, or sociology.

It appears that the idea that the field of interhuman relations should be a major area for man's study and endeavor is not yet sufficiently accepted for any university to have developed a teaching course to train this type of expert. It may well be asked whether such a course could be given and whether there are people capable of teaching it. It is clear that something is known of the subject; social psychologists, social anthropologists, and psychiatrists have been working in that area, at least to some extent, for many years. It does appear, however, that their experiences have not properly been brought together into teachable form. Here is a job of the greatest possible urgency. It is to be hoped that enough demand will arise, from enough places, to insure that the World Federation for Mental Health and the World Health Organization will quickly undertake developmental work of this kind. The Society for the Psychological Study of Social Issues could perform most valuable services in stimulating and helping to guide such developments.

It may well be claimed that all that is needed is the universal application of the ancient injunction to "love thy neighbor as thyself," which derives from the deep gregarious instinct of man and has been promulgated by most of the great religions. In practice such love has commonly been restricted, according to a locally acceptable definition of "neighbor," to the other members of the tribe or the color, racial, religious, or political group. The requirements for maturity and world citizenship may be called the Christian virtues, the Buddhist virtues, the Hindu virtues, the Mohammedan virtues, or the Confucian virtues, or may be ascribed to many other religions with about equal validity. They could even be called the "psychological virtues."

The catch in this old and widely supported injunction, "love thy neighbor as thyself," is in the last two words. The uncomfortable fact is that very few people indeed can love themselves in a healthy natural way which tolerantly accepts all their own human urges as normal and inevitable aspects of the healthily functioning man or woman. Most of us, by being civilized too early or too forcibly, have been driven to believe that our natural human urges are "bad," "not nice," "wicked," "sinful," or whatever the local equivalent may be. This is the dreadfully damaging concept of "original sin," which really only states that babies are not born civilized according to the local customs of the natives. In this latter form the statement is, of course, true and quite harmless, as long as it is understood by the child that he is not supposed to have been born civilized and, by permission of all legal systems, may take plenty of time about reaching that exalted state. Unfortunately, this is not understood by most children; they have been convicted of sin, believe they are "bad," and consequently deeply despise, distrust, and even hate themselves. The anxiety engendered motivates the projection of these feelings of despising, distrust, and hate on to other people, the neighbors, though usually distinguishable from oneself by some recognizable difference of race, color, creed, economic status, and politics.

The consequent aggressive feelings against such people are experienced as virtuous. It appears that a system which imposes an early belief in one's own sinfulness, or unacceptability in one's natural state, with its consequent inferiority feelings and anxiety, must be harmful to interhuman relationships and to the ability of the human race to survive in the kind of world this has become.

Unfortunately, the concept of "sin" is, under one name or another, very firmly entrenched throughout much of the world. Later in life the feelings which go with this childhood condemnation commonly are attached to thinking or other activities which would be disapproved by prevailing authority. Instead of "bad," one may be reproached with the terms "communist," "reactionary," "Nazi," "nigger-lover," or any of many other epithets. They all signify disapproval and are supposed to produce feelings of guilt and shame. This method of control has been used by all authoritarian systems throughout history to discourage any attempts to change or develop local concepts or customs. This whole method of control should be exposed and combatted by all scientific or mature people.

Let us look briefly at some of the immediate requirements that are not so obvious that no further research is needed to identify them. Much reliable work of recent years has indicated clearly that successful human relations start in infancy. We all know that babies need—not just want, but need—completely uncritical love, love whose manifestations are quite independent of the babies' behavior. In this situation only can the most desirable feelings of being wanted and loved and of "belonging" arise. It is also well known that this "belonging" feeling, in a successful developmental process, should spread gradually to include family, friends, and fellow citizens, and that in the little world this has become, it can no longer safely stop at national boundaries as it reasonably satisfactorily could until just recently.

Now the world must have, and soon, large numbers of people in every country who have grown emotionally beyond national boundaries and are sufficiently mature to be capable of being "world citizens." Up until now very few people indeed in any country have really developed emotionally even to a truly national degree of maturity. Such development to a national level requires an equal degree of concern for the welfare of *all* the kinds of people within the nation, irrespective of color, racial origin, religion, education, social or economic group, or even political party. Few people have reached even this stage of development, and yet only through this stage is it possible to develop to a degree of maturity in which there is a "belonging" feeling in relation to all peoples and an equal concern for the welfare of all of them. Very few such people have been developed, but it is clear that they are the prototype of what the world must have, in large numbers, before there can be any reasonable degree of assurance that the human race will survive for even another generation.

How can the development of this "belonging" feeling be ensured for as many as possible of the children now beginning their lives? It is already clear that they must experience unquestioning and uncritical love, and that they must be free of a "conviction of sin." What else must they have and against what else must they be protected? What are the needs of the growing child of school age, of the adolescent, of the young adult, which need to be met by the community in order that the best possible opportunity to reach real maturity may be ensured?

Next, the responsibility of meeting these needs must be broken down and allocated to the appropriate elements of the community. What do mothers, to be successful mothers, need to know about these matters, and how should they apply their knowledge? What about fathers? What training should they have for their job? Who should provide the training for mothers and fathers, and when? An answer to this last question is easy: training of mothers and fathers ideally should begin when they themselves are children, but clearly we cannot wait for another two generations. This job must be got at at every possible point of contact. Margaret Mead recently stated that even grandparents can still learn. Many of them certainly can if they receive a little help and are given a chance to recognize their responsibilities.

What do school teachers need of this type of knowledge, and who is responsible for seeing that they get it? What are the responsibilities of town and city councils, of other local authorities, and of state, provincial, or federal governments, and how are local and national institutions to be made aware of these responsibilities and induced to accept them? What kinds of people are needed locally on boards of education or school boards? What should their qualifications be? What do members of city councils need to know about the development of children so they may carry their share of this responsibility? Is it conceivable that it could be generally enough accepted that members of parliaments and congressmen—even senators—need a certain amount of knowledge in this most important field of their responsibilities to the citizens who elect them? What should be the qualifications of legislators to be able so to direct the affairs of a country, particularly in relation to other countries, that the citizens whose lives are in their hands may feel some assurance that they know what they are doing and are working for the good of all the people in the world, the only basis on which it is reasonable to hope that the human race and our own children may survive?

Here are a few of the questions that need to be answered, not by individual research reported in technical language to scientific societies, but by cooperative work eventually reported in nontechnical language to the people of the world through their common channels of communication, the United Nations and its Specialized Agencies. Much of this has already been begun. The statement by the International Preparatory Commission for the International Congress on Mental Health is a notable contribution to these problems. Another significant move has been made by UNESCO's project on Intergroup Tensions, from which has come recently a very valuable report. Of course, these efforts, while tremendously important, are only beginnings. One of their great values is the indication they give that there are at least a few mature people, capable of cooperation in this most difficult of all scientific fields, in many countries.

A few fully mature people, even in the right places, are not enough. Even if all the councils of the United Nations and of its agencies were composed of such people, which they are not, they could still be only partly effective. The United Nations and its agencies are not run by their secretariats. All policies are decided by the governing bodies, executive boards, councils, etc., all composed of national delegations. Even now, many national delegations cannot behave in as civilized, mature, and cooperative ways as they know they should do and as they would like to do because of the certainty that such civilized, mature, and cooperative action would not be acceptable to their own governments or political chiefs. A national delegation cannot misrepresent its own people at home. If the majority of the population of a country is insular, or prejudiced, or antagonistic against some other nation, or aggressive, or just plain ignorant, its delegations in the councils of the nations must reflect those qualities in order to keep their jobs.

The United Nations cannot be blamed for the muddles they have made or their failures in human relations. These muddles and failures are the direct results of the muddled thinking of the people of the nations, of their prejudices, their unreasoned anxieties and hates, and their aggressive pressures. This situation cannot be cured, nor can it be much improved from within the United Nations Organization itself. The degree of our own infantility is illustrated by our desire to leave these responsibilities to our "father-equivalent," the government of our particular country or the United Nations. The reform must take place within the nations. Nor can such reforms stem from the national capitals, from the parliaments and congresses. No one can do this extremely necessary job but the people themselves, in the villages, towns, and cities of every country.

There is now only one basic importance in the world, the one importance on which the very existence of the race depends—the emotional relationship between the people of the world. Every political action in every country should be taken in the light of that fact. Whoever helps to elect anyone to any public office, in any country, on any other basis than his ability to improve the human relations of the people of the world, gambles with his own life and the lives of his children against, it may be, his hope of a job or of lowered taxes or of the satisfaction he might get in being on the winning side in a battle between political parties. Any or all of these things, weighed against the lives of the hundreds of millions of people the next world war, if it comes, will destroy, make a poor bet.

Our own personal responsibility to our fellow humans is clear. Whoever is reasonably informed in

(*Continued on page 43, column 2.*)

TECHNICAL PAPERS

Synthesis of Enantiomeric α-Lecithins[1]

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Lecithins containing only saturated fatty acids, known as hydrolecithins, have been shown to occur in nature (*3*, *4*, *6*, *7*). Although numerous attempts have been made to synthesize hydrolecithins, none of these syntheses has yielded the desired product. We have recently accomplished the synthesis of several pure α-hydrolecithins of known spatial arrangement. An α,β-diglyceride in its D-, L-, or racemic form is phosphorylated with monophenylphosphoryl dichloride in the presence of pyridine. The reaction product, without isolation, is immediately esterified with choline chloride. The diacyl-α-glycerylphenylphosphorylcholine chloride is isolated and purified via the reineckate. The reineckate is converted to the sulfate and the protective phenyl group removed by catalytic hydrogenolysis. After elimination of the sulfate ion the resulting hydrolecithin is isolated and is purified by crystallization from a suitable solvent such as diisobutyl ketone.

The following three L-α-hydrolecithins have been synthesized by using as starting materials the corresponding D-α,β-diglycerides, which were prepared according to the procedure described by Sowden and Fischer (*5*):

L-α-distearoyl lecithin (DSL): $C_{44}H_{90}O_9NP$—*Found.* C, 64.6; H, 10.84; N, 1.85; P, 3.81. $[\alpha]_D^{26} + 6.1°$ in chloroform-methanol 1 : 1, c 4.2; $M_D + 49.3°$.

L-α-dipalmitoyl lecithin (DPL): $C_{40}H_{82}O_9NP$—*Found.* C, 63.9; H, 11.1; N, 1.87; P, 4.13. $[\alpha]_D^{23} + 6.7°$ in chloroform-methanol 1 : 1, c 4.2; $M_D + 50.2°$.

L-α-dimyristoyl lecithin (DML): $C_{36}H_{74}O_9NP$—*Found.* C, 62.0; H, 11.1; N, 1.97; P, 4.43. $[\alpha]_D^{23} + 7.0°$; $M_D + 48.5°$.

The molecular ratio of choline : phosphoric acid : fatty acids in the synthetic lecithins was found to be very close to 1 : 1 : 2. The three synthetic lecithins, after crystallization from diisobutylketone, gave distinct X-ray diffraction patterns which establish their crystalline structure.

The solubilities of the crystalline lecithins in various solvents were determined. The following values, while not precise, indicate the approximate magnitude of solubility of DSL, DPL, and DML at 22–23° expressed as g/100 ml of solution: dry acetone, 0.01, 0.02, and 0.06, respectively; dry ether, 0.02, 0.02, and 0.03; dry ethanol, 0.8, 1.5, and > 15. In addition, all three lecithins are readily soluble both in glacial acetic acid and in chloroform at room temperature, as well as in hot diisobutyl ketone.

The synthetic L-α-dipalmitoyl lecithin was found to be identical with dipalmitoyl lecithin isolated from natural sources (Thannhauser and associates). Thus, the optical purity of the synthetic product and the stereochemical classification of the natural product are established (L-series). The close similarity of the molecular rotation of DPL to those of DSL and DML is a reasonable assurance that both DSL and DML have also been obtained as pure enantiomers and that the synthesis described is one of general application.

Because of the peculiar kind of stereochemistry of asymmetrically substituted glycerol derivatives an unusual situation presents itself: if we consider any particular lecithin as having been derived from the corresponding diglyceride, it would be assigned to one particular stereochemical series, whereas if we consider the same compound as a derivative of the glycerylphosphorylcholine moiety, it would be assigned to the opposite stereochemical series. The reason for this unusual situation is fully discussed elsewhere (*2*). Confronted with the necessity of assigning a stereochemical designation to the synthetic lecithins, an arbitrary choice had to be made between the two possibilities mentioned above. Since the diglyceride portion of the molecule varies from lecithin to lecithin, it seemed logical to choose as a reference compound the glycerylphosphorylcholine moiety, because it is common to all lecithins. The stereochemical relationship of the α-glycerylphosphorylcholines to the glyceraldehydes, the final reference compounds, has already been established (*1*). Thus, by definition, synthetic and natural lecithins containing the L-α-glycerylphosphorylcholine belong to the L-series.

The synthetic procedure described above makes available for the first time individual lecithins of proven configuration and constitution upon which to conduct systematic zymological and other biochemical and physiological studies.

The experimental details will be reported shortly.

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Notes on the Life History of a Brachylaemid Trematode

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All stages in the life cycle of a brachylaemid trematode have been observed in experimental infections. The cercariae are produced in branched sporocysts in the digestive gland of *Anguispira alternata*; they emerge from the snail and penetrate the same or another individual of *A. alternata* or *Polygyra thyroidus*, migrate to the pericardium, but do not encyst. Developmental and sexually mature stages have been recovered from *Peromyscus leucopus* and from the white mouse. Eggs are produced at about 13 days after ingestion of metacercariae by a white mouse and appear in the feces at about 21 days.

The adult measures 3.5 × 2.0 mm. The oral sucker is 500 × 580 μ, and the ventral sucker, 460 × 560 μ. The pharynx is muscular; the caeca loop back and forth, extend to the posterior end of the body, and have numerous evaginations on both lateral and medial sides. The gonads lie close together, forming a triangle in the most posterior portion of the worm, with one testis on the left side, one in the midline and posterior, and the ovary on the right. The testes are indented. In a mature worm from *P. leucopus* the left testis measures 420 × 460 μ; the posterior one, 460 × 540 μ. The ovary is smooth and measures 650 × 550 μ. The genital pore is median, at the level of the anterior testis. The vitellaria are lateral, follicular and sparse, and extend from the pharynx to the ovary. The uterus fills the body between the caeca from the oral sucker to the anterior testis. Both ascending and descending loops are much convoluted; the descending loop is conspicuous in the dorsal midline. The main collecting ducts of the excretory system are lateral to the caeca, and the bladder empties through a posterior pore.

The thin-shelled but somewhat yellowish egg measures 32 × 18 μ. The shell is thicker at the adopercular end than elsewhere. Miracidia are visible in the eggs when they are passed by the mice. The larvae do not move, but the adopercular half appears to be ciliated.

The sporocyst is much branched and dendritic and ramifies through the entire liver of the snail. The branching of a fragment is irregular, starting from a roughly defined main trunk. Each branch, but not the main trunk, is divided by constrictions, and may end in a filament with a terminal knob. All parts of the sporocyst except the constrictions are filled with cercariae in different stages of development. Some portions of the sporocyst contain but one cercaria between constrictions; others, from two to many. No birth pore has been observed.

Cercariae washed from the surface of infected snails are about 250 μ long when extended. The tail is a small protuberance in a posteroventral position; the caeca are broad and extend to the level of the center of the ventral sucker; and a prepharynx and short esophagus are visible in a fully extended cercaria. The cuticle bears a few widely-scattered, conspicuous projections, possibly sensory. Just posterior to the ventral sucker is a germinal mass. The flame cell pattern has not been entirely worked out, but there appear to be 5 flame cells in each anterior quadrant and 4 in each posterior one. The vesicular bladder empties through two ducts leading to pores on the tail.

The metacercariae are over 1 mm long at maximum size, broad, white and somewhat concave ventrally. The caeca extend to the posterior end and are looped back and forth. There is a thick cuticle which, in the living worm, is transversely folded and may present a spinous or scale-like appearance. Three distinct gonad rudiments are present. After three weeks in the second intermediate host the worms still have the cercarial tail, although they are larger and the caeca have increased in length.

This trematode possibly is identical with the metacercaria described by Leidy in 1847 as *Distoma helicis* (renamed *D. pericardium* by Creplin, 1849), and with *D. vagans* Leidy (1850). The morphological and taxonomic features will be presented in a later publication.

Vitamin B_{14} and Cell Proliferation

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A crystalline compound has been isolated from urine which had a very high activity on cell proliferation *in vitro* and on hemopoiesis *in vivo*.

From 100 liters of normal human urine 33 mg of a material was obtained as balls of small brown crystals which is designated here as vitamin B_{14}, although its origin and function is probably more that of a hormone than a vitamin. On analysis the material was found to contain 19.6% nitrogen and 4.0% phosphorus. Sulfur was not present. Cobalt was absent, or, if present, there was so small a fraction of a per cent that it could not be considered anything but an impurity.

Rickes, *et al.* (*4*), Shorb (*5*), and West (*7*) have reported a cobalt-containing compound (vitamin B_{12}) isolated from liver, which had a hematological activity in cases of addisonian pernicious anemia. Smith (*6*) described a pigment from liver as an antipernicious anemia factor which may be identical with vitamin B_{12}.

The activity of vitamin B_{14} was tested on bone marrow cultures by the technique previously described (*1*). The results are given in Table 1. The table shows that in bone marrow cultures vitamin B_{14} is at least 5,000,000 times as effective as xanthopterin, or 1×10^{-6} γ/ml of cell suspension gives an increase in the rate of cell proliferation similar to 5 γ/ml of xanthopterin. Vitamin B_{14} was not toxic in concentrations up to 100 γ/ml. Its effect in accelerating cell proliferation is counteracted by 2-amino-4-hydroxy-7-methyl pteridine (7MP), which also counteracts the effect of xanthopterin.

The effect of pterins on cell proliferation in a suspension of cells of neoplastic tissue is opposite to the effect on cells of bone marrow suspension or of normal tissue (*3*). Xanthopterin accelerates proliferation of bone marrow cells and inhibits neoplastic cells. 7MP inhibits bone marrow cell proliferation and accelerates proliferation of cells of neoplastic tissue. Table 2 shows the effect of vitamin B_{14} on a cell suspension of Brown Pearce rabbit tumor.

TABLE 1

EFFECT OF VITAMIN B_{14} ON CELL PROLIFERATION *in vitro* IN A BEEF BONE MARROW SUSPENSION*

Supplement/ml of suspension	Final concentration (RBC/mm³)	Increase in RBC (%)	Final concentration (NC/mm³)	Increase in NC (%)	Retic. /1,000 RBC
None	5,850	19	4,720	64	15
5γ xanthopterin	10,000	120	8,170	184	33
5γ 7MP	2,680	-46	1,680	-42	5
1×10^{-6}γ vit. B_{14}	12,800	161	6,850	138	30
1×10^{-5}γ vit. B_{14}	24,500	400	19,800	665	37
1×10^{-4}γ vit. B_{14}	39,000	695	33,900	1,080	50
1×10^{-2}γ vit. B_{14}	40,200	720	34,200	1,090	46
10γ vit. B_{14}	42,500	760	38,800	1,070	63
100γ vit. B_{14}	41,500	750	32,400	1,020	53
1×10^{-4}γ vit. B_{14} plus 5γ 7MP	28,100	472	23,800	760	40
1×10^{-4}γ vit. B_{14} plus 10γ 7MP	15,600	238	10,800	276	25

* Initial concentration of cells in the suspension: RBC, 4,910/mm³; nucleated cells (NC), 2,880/mm³; reticulocytes, 9/1,000 RBC. Time of incubation, 7.5 hrs at 37° C.

TABLE 2

EFFECT OF VITAMIN B_{14} ON CELL PROLIFERATION *in vitro* IN A SUSPENSION OF BROWN PEARCE TUMOR CELLS*

Supplement/ml of suspension	Final concentration (cells/mm³)	Increase in cells (%)
None	11,200	26
5γ 7MP	15,000	68
10γ 7MP	17,500	96
5γ xanthopterin	6,760	-24
10γ xanthopterin	4,600	-48
1×10^{-7}γ vit. B_{14}	7,960	-11
1×10^{-6}γ vit. B_{14}	4,850	-46
1×10^{-4}γ vit. B_{14}	3,120	-65
1×10^{-2}γ vit. B_{14}	1,320	-85
1×10^{-6}γ vit. B_{14} plus 5γ 7MP	9,100	2
1×10^{-6}γ vit. B_{14} plus 10γ 7MP	11,200	26

* Initial concentration of suspension: 8,920 cells/mm³. Time of incubation, 5 hrs at 37° C.

The technique used in culturing the tumor cells was the same as that previously described (*3*). Vitamin B_{14} is about 10,000,000 times as effective as xanthopterin in inhibiting cell proliferation *in vitro* in a suspension of tumor cells, or 1×10^{-6} γ/ml of vitamin B_{14} had about the same effect as 10 γ/ml of xanthopterin. The effect of 1×10^{-6} γ/ml of vitamin B_{14} was completely counteracted by 10 γ/ml of 7MP, or 1×10^{-6} γ/ml of vitamin B_{14} plus 10 γ/ml of 7MP gave the same rate of proliferation as with no supplement.

In rats made anemic with sulfathiazole by the procedure previously described (*2*), a single injection of 0.01 γ of vitamin B_{14} was as effective in alleviating the anemia and leukopenia as a single injection of 1 mg of xanthopterin.

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Action of Enzymes on Vitamin B_{14} and Pteridines

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The activity of xanthopterin and pteroyl derivatives in accelerating the rate of cell proliferation *in vitro* and in producing hemopoiesis in anemic rats has been found to be greatly increased by the action of certain enzymes.

Xanthine oxidase was prepared from milk and purified by repeated precipitation with ammonium sulfate. The enzyme preparation was very active when measured in a Thunberg tube with methylene blue, using either xanthine or xanthopterin as the substrate. Xanthopterin and folic acid (pteroylglutamic acid) were incubated with the enzyme, under toluene, at 37° C with a phosphate buffer of pH 7.4. Aliquots were removed at intervals for analysis. There was a very marked change in the absorption spectrum, which will be reported later. Kalckar, *et al.* (*1*, *2*) have studied some phases of the action of the milk enzyme on xanthopterin.

The effect on cell proliferation of the products resulting from the enzyme action was measured by the technique previously described (*3*). Table 1 gives a summary of typical results obtained.

The activity of both xanthopterin and folic acid was increased by the action of the enzyme. The effect is most noticeable in the case of folic acid. At zero time the number of cells produced in the incubation of the bone marrow culture were the same with folic acid present as with no supplement. After the action of the enzyme the product formed from folic acid very greatly increased the rate of proliferation of both RBC and nucleated cells (NC). As previously pointed out (*3*), the reticulocyte count is roughly proportional to the rate of erythrocyte formation.

TABLE 1

EFFECT OF THE PRODUCTS FORMED BY THE ACTION OF XANTHINE OXIDASE FROM MILK ON RATE OF CELL PROLIFERATION IN BONE MARROW CULTURE*

Supplement/ml of suspension	Final concentration (RBC/mm^3)	Increase in RBC (%)	Final concentration (NC/mm^3)	Increase in NC (%)	Retic. /1,000 RBC
None	10,600	24	6,120	44	18
5γ 7MP	4,520	−47	280	−93	4
1 × 10^{-7}γ vit. B_{14}	17,800	108	13,640	222	36
5γ xanthopterin enzyme—zero time	16,880	98	11,700	175	32
5γ xanthopterin enzyme—5 days	25,200	195	21,900	416	52
5γ folic acid enzyme—zero time	10,640	24	6,560	55	18
5γ folic acid enzyme—5 days	24,300	183	18,900	345	42

* Time of bone marrow incubation, 6 hrs; concentration of initial bone marrow suspension: RBC, 8,550/mm^3; NC, 4,240/mm^3; reticulocytes, 11/1,000 RBC.

TABLE 2

EFFECT OF THE PRODUCTS FORMED BY THE ACTION OF ENZYMES FROM RAT LIVER HOMOGENATE ON THE RATE OF CELL PROLIFERATION IN BONE MARROW CULTURE*

Supplement/ml of suspension	Final concentration (RBC/mm^3)	Increase in RBC (%)	Final concentration (NC/mm^3)	Increase in NC (%)	Retic. /1,000 RBC
Liver homogenate (LH)—zero time	9,680	91	5,690	119	24
Liver homogenate (LH)—5 hrs, 37° C	11,400	124	8,400	223	32
5γ xanthopterin plus LH—zero time	18,800	270	15,100	480	34
5γ xanthopterin plus LH—5 hrs	20,400	300	10,600	650	56
5γ folic acid plus LH—zero time	9,100	79	7,100	173	20
5γ folic acid plus LH—5 hrs	16,400	224	13,400	455	42
5γ teropterin plus LH—zero time	9,360	84	6,880	165	24
5γ teropterin plus LH—5 hrs	16,200	219	12,000	360	36

* Time of bone marrow culture incubation, 8 hrs; concentration of initial bone marrow suspension: RBC, 5,080/mm^3; NC, 2,600/mm^3; reticulocytes, 8/1,000 RBC.

Liver homogenate contains an oxidizing system which will use xanthine or xanthopterin as the substrate in a Thunberg tube with methylene blue. Xanthopterin, folic acid, and teropterin were incubated with a homogenate prepared from rat livers in a Waring blendor. The effect upon cell proliferation in bone marrow culture *in vitro* is shown in Table 2.

Folic acid and teropterin did not produce a greater rate of proliferation than the liver homogenate without supplement before incubation. After incubation with the homogenate the products formed did increase the rate of cell production. The inhibiting action of 2-amino-4-hydroxy-7-methyl pteridine (7MP) was not appreciably changed by incubation with the liver homogenate. The data for 7MP are not included in the table.

TABLE 3

EFFECT OF THE PRODUCTS PRODUCED BY THE ACTION OF ENZYMES FROM RAT GASTRIC MUCOSA ON THE RATE OF CELL PROLIFERATION IN BONE MARROW CULTURE*

Supplement/ml of suspension	Final concentration (RBC/mm^3)	Increase in RBC (%)	Final concentration (NC/mm^3)	Increase in NC (%)	Retic. /1,000 RBC
Enzyme only (EN)—zero time	8,480	22	6,480	51	16
Enzyme only (EN)—72 hrs	8,300	20	6,250	46	16
2γ xanthopterin plus EN—zero time	13,240	91	9,250	116	30
2γ xanthopterin plus EN—72 hrs	36,500	430	14,600	242	48
5γ folic acid plus EN—zero time	8,320	20	6,050	42	16
5γ folic acid plus EN—72 hrs	37,500	440	16,200	278	62
2γ vitamin B_{14} plus EN—zero time	38,000	450	18,800	340	54
2γ vitamin B_{14} plus EN—72 hrs	39,200	460	17,600	310	48

*Time of bone marrow incubation, 5.5 hrs; concentration of initial bone marrow suspension: RBC, 6,920/mm^3; NC, 4,280/mm^3; reticulocytes, 11/1,000 RBC.

Gastric mucosa has been associated with hemopoiesis and with the intrinsic factor of Castle. The gastric mucosa of several rats was disintegrated in the Waring blendor with phosphate buffer at pH 7.4, centrifuged, and filtered. The extract contained an oxidase system which would use xanthine or xanthopterin as a substrate in the Thunberg tube with methylene blue. Xanthopterin, folic acid, and vitamin B_{14} were incubated under toluene at 37° C with the gastric mucosa extract. A few results are shown in Table 3.

The activity of the enzyme preparation without supplement did not change during incubation. Folic acid plus the enzyme, when first mixed, gave the same activity or rate of cell proliferation as the enzyme alone. After incubation with the enzyme the products from folic acid and xanthopterin produced a rate of cell proliferation approximately equal to that produced by vitamin B_{14}. The activity of vitamin B_{14} was not altered by incubation with the enzyme preparation.

A single injection of microgram levels of the products produced by both milk and stomach mucosa enzymes on xanthopterin and on folic acid caused a rapid rise in RBC, WBC, and reticulocytes in rats made anemic on a purified diet plus sulfathiazole, equivalent to the effect of 1 m/kg of xanthopterin by the technique previously described (*4*).

The above experiments explain much of the confusion and conflicting results that have been obtained in the study of the extrinsic and intrinsic factors of Castle. Apparently the extrinsic factor may not be a single substance, but xanthopterin, folic acid, teropterin, and possibly other pteroyl derivatives may serve as the extrinsic factor. Enzyme systems which were present and which were very strong in the gastric mucosa extract and present in the milk xanthine oxidase preparation and the liver homogenate, served as the intrinsic factor. Vitamin B_{14} and the products produced by the action of the oxidase systems on xanthopterin and folic acid appeared to be not identical compounds, although they had similar activity when measured by the techniques used. The end-products of the action of milk, liver, and gastric mucosa enzymes on a single substrate may be different. The active material from xanthopterin is not leucopterin. The chemistry of the various materials is under investigation.

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A Synthesis of Benzene, Toluene, and Benzoic Acid Labeled in the Ring With Isotopic Carbon

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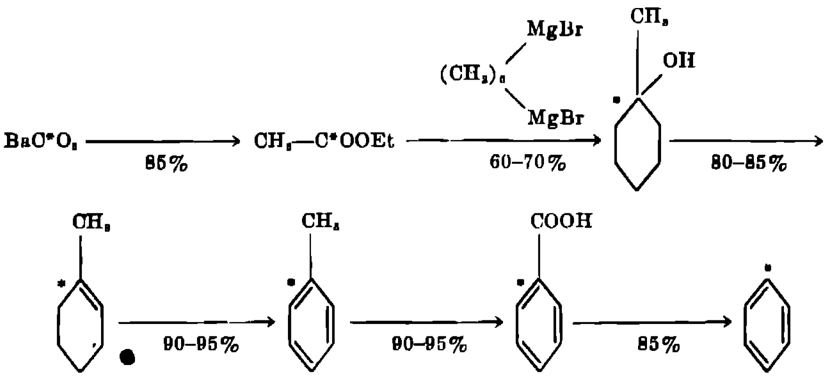
The development of an efficient procedure for the synthesis of benzene, toluene, and benzoic acid labeled in the ring with carbon 13 or carbon 14 is of considerable interest because of the utility of these aromatic compounds in the preparation of numerous substances of importance in organic chemistry, medicine, and biology.



While the synthesis of C^{14}-labeled mesitylene (*2*) affords an intermediate for the preparation of tagged benzene, this procedure suffers from the disadvantages that half of the radioactivity is converted to barium carbonate in an early step of the synthesis and the over-all yield is quite low.

We have found a satisfactory route to toluene and benzoic acid labeled on carbon 1 of the ring and to tagged benzene in the sequence of reactions illustrated above.

The synthesis of carboxyl-labeled ethyl acetate was accomplished by carbonation of methyl magnesium iodide with isotopic carbon dioxide, followed by reaction of the sodium acetate with diethyl sulfate in a modification of the procedure of Sakami, Evans, and Gurin (*4*). Preparation of 1-methylcyclohexanol-1 labeled on carbon 1 was achieved by reaction of carboxyl-labeled ethyl acetate with the Grignard reagent from pentamethylene dibromide according to the procedure of Grignard and Vignon (*1*). Dehydration of the carbinol with iodine as described by Mosher (*3*) afforded 1-methylcyclohexene, which was converted to toluene by vapor-phase dehydrogenation over platinized asbestos (*6*). The benzoic acid, prepared by oxidation of toluene with potassium permanganate (*5*), underwent smooth decarboxylation on treatment with copper oxide and quinoline. The over-all yields from barium carbonate varied from 35 to 50% for toluene, from 3 to 40% for benzoic acid, and from 25 to 40% for benzene.

A particularly attractive feature of this synthesis is the production of toluene and benzoic acid singly labeled on a specific position of the ring. Complete details of the work will be published elsewhere.

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A Comparative Study of the Hemoglobin and Red Blood Cells of Representative Diving and Dabbling Ducks[1]

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During the course of an investigation of the adaptations of certain aquatic birds for underwater progression, the blood of a considerable number of diving and dabbling ducks was analyzed, and an attempt was made to ascertain whether or not the characteristic swimming and feeding habits of these two groups of birds may be correlated with their hemoglobin concentration and red blood cell counts.

The 27 diving ducks (Redhead and Greater Scaup) used in this study were trapped on Cayuga Lake between February 20 and March 4, 1946, and the 18 dabbling ducks (Black, Mallard, and Black × Mallard hybrids), between March 5 and 21, 1948. In all cases examinations of the blood were made within 48 hrs after trapping.

Each blood sample of approximately 0.2 cc was drawn into an oxalated pipette from the large basilic vein on the ventral surface of the elbow. The sample was then placed in a vial containing a small amount of powdered heparin. The pipettes for the Hb and RBC determinations were filled from this vial at leisure without danger of clotting. Because of the rapidity with which avian blood coagulates, this method of taking a blood sample was found to be more satisfactory than the usual procedure of cutting a wing vein and drawing up into the counting pipettes the free-flowing blood.

Hemoglobin concentrations were measured as acid hematin with a Fisher Electro-Hemometer.[2] The red blood cell counts were made in duplicate with a Spencer Bright-Line Haemacytometer, and an error of 5% was allowed between counts. Color indices served as a check on the probable accuracy of these determinations and were calculated according to the formula:

$$\frac{\text{gm Hb/100 cc individual sample}}{\text{gm Hb/100 cc mean value for species}}$$

divided by

$$\frac{\text{individual RBC count}}{\text{mean RBC count for species}} \ (\mathit{2}).$$

Statistical significances were derived by the methods of Snedecor (*3*).

Repeated Hb and RBC determinations, at intervals of 1–3 weeks, were made on the blood of 5 Mallard ducks over a 60-day period. These data, together with the total body-weight changes, are plotted in Fig. 1. During this period the birds were well fed and housed in an outdoor cage, and a careful record of their weight was kept. With one exception, no appreciable loss of weight occurred during this time, and the birds remained in good health.

TABLE 1

HEMOGLOBIN CONCENTRATIONS AND RED BLOOD CELL COUNTS IN DIVING AND DABBLING DUCKS

Species	No. examined	Mean Hb* (gm/100 cc)	Range	Mean RBC† (millions/mm³)	Range	Color index range
Redhead	10♂, 1♀	18.2±0.5	16.2–20.5	3.30±0.07	3.00–3.69	0.87–1.14
Greater Scaup	9♂, 7♀	17.8±0.6	13.0–20.2	3.08±0.10	2.42–3.74	0.78–1.14
Combined diving ducks	19♂, 8♀	18.0±0.4	13.0–20.5	3.21±0.07	2.42–3.74	0.80–1.18
Mallard	8♂, 5♀	18.0±0.6	13.1–23.5	3.59±0.12	2.90–4.60	0.90–1.12
Black	1♂ (?)	17.0	....	3.56	....	....
Hybrid (Black × Mallard)	3♂, 1♀	18.1±0.6	16.4–19.5	3.57±0.14	3.21–3.90	0.99–1.01
Combined dabbling ducks	12♂, 6♀	18.0±0.5	13.1–23.5	3.58±0.10	2.90–4.60	0.90–1.11

* Values of P are all greater than .5 for comparison of Hb between species.

† Values of P for comparison of RBC counts between species are as follows: Mallard-Greater Scaup—P less than .01; Mallard-Redhead—P between .1 and .2; Greater Scaup-Redhead—P between .05 and .02.

The analyses revealed no significant differences in hemoglobin concentration, either between species within a group or between the two groups (diving and dabbling ducks) investigated. Differences in red blood cell counts of the species studied were as follows: (a) Greater Scaup had fewer RBC than Mallard (difference significant); (b) Greater Scaup had fewer RBC than Redhead (difference probably significant); (c) Redhead had fewer RBC than Mallard (difference not significant).

Color indices for the species studied, with one or two possible exceptions, all fell within the range considered normal for human blood (*1*).

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[1] The writers wish to acknowledge the assistance of Dr. Juanita S. Newcomer in connection with some of the hemoglobin and red blood cell determinations. Expenses incurred during the course of this investigation were met in part by a grant from the Mrs. Dean Sage Research Fund.

[2] In a few birds Hb concentrations were also measured by the oxyhemoglobin method, using a Sheard-Sanford photoelectrometer, and the values agreed closely with those measured as acid hematin.

Repeated Hb and RBC determinations on the blood of 5 Mallard ducks, which at first sampling exhibited a considerable range, revealed that those ducks having Hb and RBC values at the extreme ends of the range tended to approach, over a 60-day period, the mean for the group (see Fig. 1).

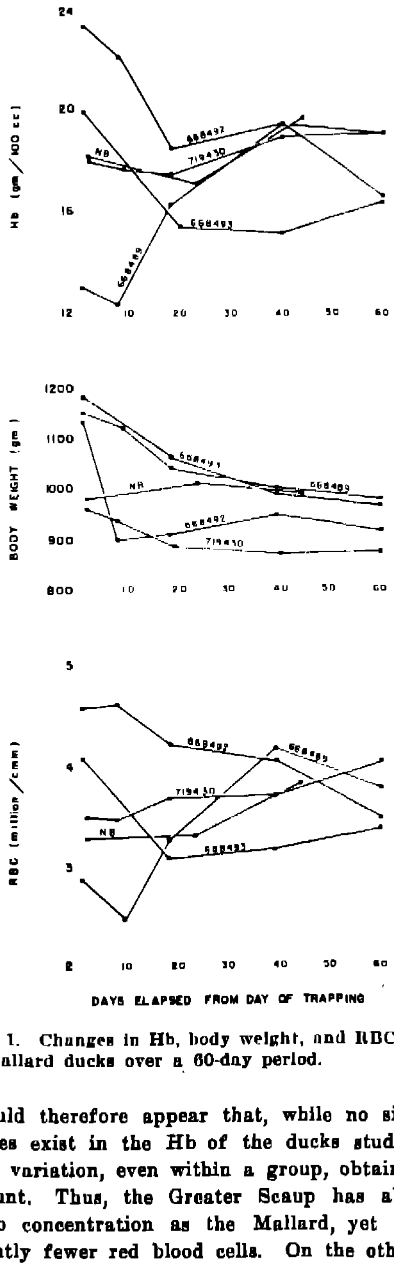

FIG. 1. Changes in Hb, body weight, and RBC count, in 5 Mallard ducks over a 60-day period.

It would therefore appear that, while no significant differences exist in the Hb of the ducks studied, considerable variation, even within a group, obtains in the RBC count. Thus, the Greater Scaup has about the same Hb concentration as the Mallard, yet possesses significantly fewer red blood cells. On the other hand, the Redhead not only possesses a Hb concentration similar to that of the Mallard, but its RBC count corresponds closely also to that of the dabbling ducks.

The writers started with the initial premise that an increased oxygen-carrying capacity of the blood would be of adaptive value to the diving ducks, which characteristically swim long distances under water, and that this increased oxygen capacity might be reflected in a higher Hb concentration and RBC count. Our findings reveal, however, that neither the Hb concentration nor the RBC count can be correlated with the locomotor habits of these two groups of birds.

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Liver Damage by Desoxycorticosterone[1]

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In work on experimental production of gall-bladder disease we found that all dogs treated with desoxycorticosterone acetate[3] showed pathological changes in the liver.

Seven normal mongrel dogs (4 males and 3 females) of an average weight of 10–12 kg each received a daily intramuscular injection of desoxycorticosterone acetate, 5 mg in oil, for 5 days. After a 5-day interval, 25 mg of the drug in oil was given intramuscularly to each dog. Seven to 10 days later the animals were sacrificed and autopsied immediately. Six of the dogs had 1% salt water to drink, and one had tap water.

There were 9 control dogs. Five were untreated, and the other four (2 males and 2 females) were given the peanut oil solvent of the desoxycorticosterone intramuscularly, in the same schedule and quantity as the 7 dogs receiving the desoxycorticosterone in oil. These 4 dogs also received 1% saline to drink. Seven to 10 days after the last injection of peanut oil these dogs were sacrificed and autopsied immediately. The 9 control dogs (untreated or injected with peanut oil) appeared healthy and normal. At autopsy, all organs were normal grossly, and the animals appeared to be in good nutritional condition. The histologic examination of the organs of all animals reported in this paper was performed by our pathologist, Dr. O. Saphir. The organs of the untreated control dogs, including the liver, were found to be histologically normal. In the control animals injected with peanut oil and with only salt water to drink the organs were normal with the exception of a slight cloudy swelling of the liver in 2 of the 4 dogs.

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[1] Aided by a grant from the John D. and Fannie K. Herz Fund.

[2] The Department is in part supported by the Michael Reese Research Foundation.

The advice of Dr. R. Levine, of the Department of Metabolism and Endocrinology, is acknowledged gratefully.

[3] Desoxycorticosterone acetate and its oil solvent were furnished through the courtesy of Ciba Pharmaceutical Products, Inc.

The dogs treated with desoxycorticosterone showed no recognizable effects of the injections, except that they appeared to be more excitable than the control dogs. At autopsy the animals were found to be in a good state of nutrition. Grossly, the only consistent finding was engorgement of the livers of the treated dogs. Microscopic findings in the livers of the dogs treated with desoxycorticosterone were as follows:

No. 1: Marked hyperemia; absence of liver cord cells in the central zone; numerous areas of focal necrosis throughout; accumulation of pigment in the Kupffer cells.

No. 2: Marked hyperemia; numerous areas of focal necrosis and severe fatty degeneration of parenchymal cells; recent bile stasis.

No. 3: Marked hyperemia with foci of recent hemorrhage; focal necrosis, essentially central throughout, as in dogs Nos. 1 and 2; severe fatty degeneration of cord cells.

No. 4: Regions of central focal necrosis and severe fatty degeneration of the liver cord cells; generalized hyperemia and foci of recent hemorrhage throughout.

No. 5: Massive hyperemia and marked pigmentation of the liver cells; numerous areas of periportal fibrosis. This animal received no salt in its drinking water.

TABLE 1

PATHOLOGICAL FINDINGS IN ORGANS OTHER THAN THE LIVER

Dog No. and sex	Drinking water	Heart	Kidney	Adrenal	Spleen	Gall bladder	Pancreas	Lymph node
1, M	1% saline	Cloudy swelling	0	Hyperemia	Marked pigmentation with hemosiderin	Serosal edema extending into muscularis	Hyperemia	Chronic lymphoid hyperplasia with pigment as in liver and spleen
2, M	"	0	Cloudy swelling	Distinct cloudy swelling of zona glomerulosa and fasciculata	0	0	0	Same and hilus edema
3, M	"	0	Cloudy swelling	0	Hyperemia and pigmentation, myeloid metaplasia, hypersplenism	0	0	0
4, M	"	0	Cloudy swelling	0	0	0	0	0
5, F	Tap water	0	0	0	Marked pigmentation with hemosiderin	Serosal edema extending into muscularis	0	Chronic lymphoid hyperplasia with pigment as in liver and spleen
6, F	Saline	0	0	Hyperplasia of cortex	0	Hyperemia of submucosa	Small area of necrosis	0
7, F	Other organs not autopsied							

No. 6: Very severe acute necrosis of the liver with absence of normal architecture. In one section there is a hyaline, and an organizing thrombus in the portal vein.

No. 7: Fatty degeneration; some cloudy swelling around the central veins; no evident necrosis.

Other organs were affected less consistently and are noted in Table 1. Briefly, the following changes were found: cloudy swelling of heart, gall bladder (*4*), kidneys, and adrenal cortex, hyperplasia and edema of lymph nodes, and hyperemia, pigmentation, and myeloid hyperplasia of the spleen.

In his extensive work with desoxycorticosterone Selye (*3*) does not mention liver changes. Ellinger (*1*) reported that desoxycorticosterone protected mice against the liver damage following irradiation with X-rays. We were able to find only one report in the literature in which liver damage was associated with treatment with desoxycorticosterone. Forster, *et al.* (*2*) described findings in a boy with adrenal insufficiency who for two years received large amounts of desoxycorticosterone plus extra salt in his diet. According to the autopsy report, "the radiating pattern of the liver cords was lost completely. The cytoplasm of the liver cells was diffusely reticulated and vacuolated." Microscopic examination of the remaining organs showed no histopathological changes except in the brain. In order to investigate the lethal factors in this case, they performed experiments in 4 rats, 7 rabbits, and 1 dog. These animals were treated with large doses of desoxycorticosterone but with no excess salt, the rats for 87 days, the rabbits for 15–183 days, and the dog for 70 days. The dog received 5 mg of desoxycorticosterone daily by subcutaneous route. The microscopic findings in the dog were as follows: foamy hepatic cells with collections, in the portal area of plasma cells, eosinophiles, polymorphonuclear leucocytes and phagocytes containing brown pigment. Sections of other organs were found to be normal, except for moderate degeneration of the renal tubules. In 3 rabbits the livers disclosed a diffuse sprinkling with eosinophiles, and in the other 2 rather severe fatty changes. The livers of the rats seem to have been normal.

The changes we have observed in dogs resemble more nearly those reported in the human by Forster, *et al.* (*2*) than their findings in the dog and in the rabbits. This may be explained by the fact that their patient received additional salt while their experimental animals did not. In our dog No. 5, which received no additional sodium chloride, pathological findings in the liver were less pronounced. We feel that the periportal fibrosis found in this dog was not caused by the desoxycorticosterone, but that it may have existed before the experiment.

Thus, pathological changes in the liver were found in each of 6 dogs given desoxycorticosterone and sodium chloride. The changes in the livers consisted of focal and diffuse necrosis (essentially central), fatty degeneration, hyperemia, hemorrhage, and accumulation of pigment. One dog that had received desoxycorticosterone and no salt in his drinking water showed fewer pathologic changes, namely, massive hyperemia and marked pigmentation of the liver cells. Control dogs, receiving only peanut oil by injection and sodium chloride to drink, showed some cloudy swelling or no changes in the liver, and untreated dogs showed no pathologic changes in the liver.

It is generally conceded that noninfectious liver necrosis is due to two main factors, nutritional deficiencies or toxic substances. We feel that the effects of desoxycorticosterone on the livers of our dogs were of a toxic nature, and that the toxic effect was enhanced by the additional salt administered. The doses of desoxycorticosterone given to our dogs were relatively large, but the case of Forster, *et al.* demonstrates that overdosage of desoxycorticosterone can happen in the human and can result in severe and fatal consequences.

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The Use of an Electrolytic Injector as a "Compensating Device" in Electrophoresis

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Some form of compensation device is usually essential for experiments requiring migration over path distances greater than the actual length of the cell or for attempting electrophoretic separations of proteins. The so-called compensation device is an instrument designed to produce a very small flow of the bulk of the liquid in the Tiselius U tube in the opposite direction to the migration of the protein boundary, thus enabling the boundary to be held stationary or even moved in the reverse direction. The design of such a device has followed chiefly two main principles. First, Tiselius (*4*) obtained the displacement of the bulk liquid by slowly dropping a plunger into one of the open electrode vessels of his original apparatus. Longsworth and MacInnes (*2*) later introduced the motor-driven syringe for use with the electrophoresis apparatus which had one closed electrode vessel. A modification of the first principle enabled Svensson (*3*) to use a plunger instrument in the apparatus with both electrode vessels closed. The electrolytic injector to be described here is suited to the original apparatus of Tiselius with both electrode limbs open, or to the modification containing one closed electrode vessel.

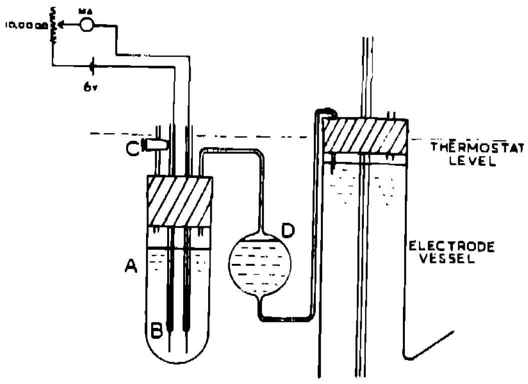

FIG. 1. Diagrammatic form of the electrolytic compensator.

The principle of electrolytic injection has been applied in many fields (e.g. *1*) since it was first described, and it remains only to give some indication of one form of the apparatus which may be used for compensation in electrophoresis. The closed vessel, A (Fig. 1), contains approximately $\frac{N}{10}$ H_2SO_4 (or any suitable electrolyte solution) and two platinum electrodes, B (wire of 0.5-mm diameter or foil), sealed in glass tubing to provide external mercury cup contacts. A capillary tap, C, enables the nozzle and bulb, D, of the injector to be filled with the buffer being used in the particular experiment. The whole may be conveniently fitted to the stand supporting the Tiselius cell and can therefore, apart from the arm entering the actual electrode vessel, be completely thermostatted. In this model, buffer solution identical with that in the electrode vessels is injected into that vessel. However, in a simpler form of the apparatus, in which a glass tube leads directly from the base of A to the electrode vessel, the electrolyte solution in A is expelled into the electrode vessel. The former arrangement is, in general, preferable. It is not essential that the injector be fitted before an experiment commences, since it is found that the disturbance to any boundary on gently dipping the nozzle just below the surface of the buffer in the electrode vessel is negligible.

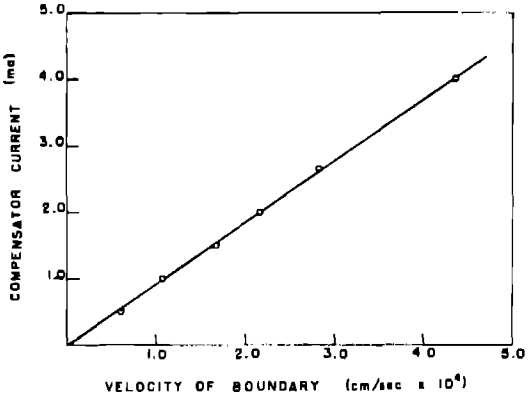

FIG. 2. Movement of a boundary formed between a 0.6% solution of ground nut globulin in phosphate—NaCl buffer (pH, 7.98; ionic strength, 0.10) and the same buffer under the influence of the compensator alone.

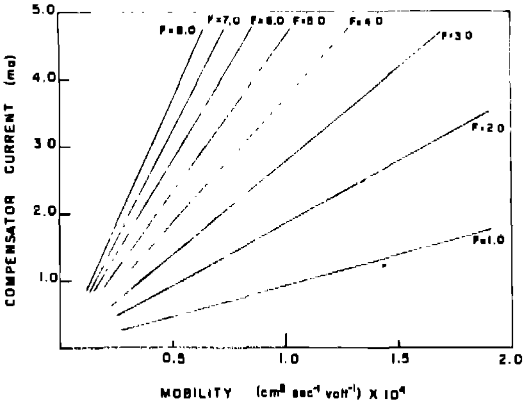

FIG. 3. Calculated mobility/compensator current for exact compensation of boundary used to obtain Fig. 2, at field strengths from 1.0 to 8.0 v/cm. F = field strength.

The injector may best be calibrated by observing the motion of a protein boundary under its influence alone, when a graph of the type shown in Fig. 2 is obtained. It is then possible, using the usual relation,

$$\text{Mobility (cm}^2\text{ sec}^{-1}\text{ volt}^{-1}) = \frac{\text{velocity (cm/sec)}}{\text{field strength (v/cm)}},$$

to construct (cf. Fig. 3) a series of linear plots of actual mobility against compensator current for exact boundary compensation at the field strengths more commonly used in electrophoresis. Mobility determinations by this method are only very approximate, and it is more convenient to use the graph of Fig. 3 to estimate the compensator current required to hold a boundary nearly stationary. The duration of the injector depends solely on the volume of the bulb. For example, a short calculation will show that for an additional path length of 8.0 cm the total volume must be in excess of 12 cc. Since the volume may comfortably be 100 cc, the electrolytic compensator will suffice for the longest experiment.

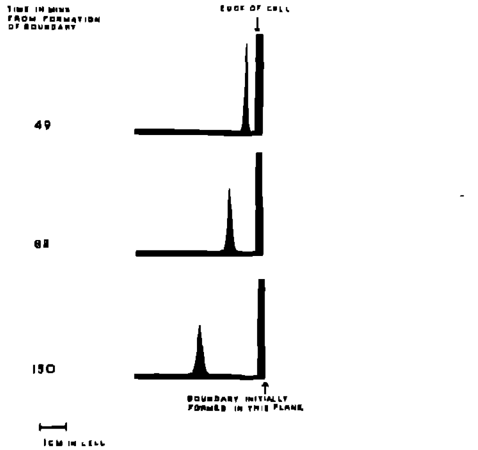
TIME IN MINS FROM FORMATION OF BOUNDARY
EDGE OF CELL
49
68
150
BOUNDARY INITIALLY FORMED IN THIS PLANE
1CM IN CELL

FIG. 4. Boundary formed between 0.6% bovine serum albumin in barbiturate buffer (pH, 8.15; ionic strength, 0.04) and the same buffer, displaced by the compensator. Compensator current, 3 ma.

An important property of the apparatus is the readily continuous control of the compensation afforded by the electrolysis. It has been used successfully to migrate protein components (of concentration down to 0.2%) over equivalent path lengths of 12 cm. At higher compensator currents it has also been used to move the protein boundaries backward to the center flange of the short section cell and hence to isolate the slowest and fastest components in the anode and cathode limbs. When the Tiselius cell is being used (without the electrode vessels) as a diffusion cell, a secondary attachment to the framework allows the nozzle of the compensator to be brought directly into one limb of the top section of the U tube. The boundaries formed in the flanges can then be moved smoothly through several centimeters to their observation positions (see Fig. 4)—a most important factor in diffusion work.

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Comments and Communications

Natural Vegetation in the Willamette Valley, Oregon

A map of the native vegetation of the United States by H. L. Shantz and Rafael Zon (*Atlas of American agriculture*, Pt. I, Sec. E. Washington, D. C.: Government Printing Office, 1924) shows the Willamette Valley to be covered with Douglas fir timber and makes no distinction between the vegetation of the valley and that of the hills and mountains on either side. In the wall atlas by J. F. Unstead, E. G. R. Taylor, and Geo. Philip, British authors, probably made from records of the Hudson Bay Company, on the map of natural vegetation in the United States, this valley is shown to be a grassland surrounded by fir forests. Which map is right, if either is?

The pioneers found the valley floor largely covered with tall grass, much of which was burned during late summer by Indians during their annual hunts. The following quotations are offered as evidence that neither of the two authorities conveys the correct impression of the country:

''Leaving the Columbia to ascend the Willamette . . ., having passed (the falls at Oregon City) by making a portage, I commenced ascending a clear . . . channel. The banks on either side were bordered with forest trees but behind that narrow belt, diversified with prairie, the landscape was magnificent.''—Quoted by R. G. Thwaites (*Early western travels*, Vol. 6, pp. 313–314) from Gabriel Franchere's Narrative, February, 1814.

David Douglas, in his Journal (November, 1826) writes: Along the Langtabuff (now the Long Tom) river—''country open, rich, level, beautiful. . . . We continued (after crossing the Multnomah, now Willamette) our northerly course over an extensive plain intersected by narrow belts of wood and groups of low oaks. . . . At mid-afternoon we came to a small stream flowing in a westerly course to the Multnomah, banks thickly covered with alder, poplar, ash, and willow. (Probably the Calapooia).''

In 1840 the missionary, Rev. G. Hines, wrote in his *Oregon history* (p. 95): ''We proceeded southward (from Salem) . . . through a country diversified with rising grounds, . . . fertile valleys variegated with here and there a group of species of red oak and now and then a stately fir which had braved the fury of a thousand storms. At nightfall we camped on the Santa Am's Fork (Santiam) . . . while the fine timber adorning its banks and the extended plains of arable land on each side hold out strong inducements to the immigrant to erect his cabin on its fertile shores.''

''Quality (now called Tualatin) Plains are distant twenty-five miles west from Oregon City; they are about twenty-five miles in length, are alternately rolling prairie and timber, surrounded by heavy growth of firs, many of which rise to the height of two hundred and fifty feet,'' says Gen. Joel Palmer in his Journal of 1845–46 (Thwaites. Vol. 30, pp. 164–190). ''The Shahalam (now Chehalem), a small stream, . . . empties into the Willamette (from the west) about twenty miles above Oregon City. It is skirted with good prairies of five or six miles in width near the mountains (Coast): but toward its mouth the valley is covered with timber and fern. . . . On the Yamhill river . . . there are firs more or less along its whole length. From the water courses, upon an average of a little over one-fourth of a mile, the valley is fine prairie land, . . . occasionally interspersed with fine groves . . . and is well covered with grass as every portion of the country that has oaken groves. Between the north and south forks of the Yamhill (west of today's Lafayette) and within six miles of their junction, commences the highlands of the Coast Range; the first plateau is about ten miles wide, and well covered with grass. The second plateau for a few miles is fern openings, with an occasional grove of timber; after this westward to the coast the country is heavily timbered with firs, pine, and occasionally cedar, hemlock, balsam, etc. . . . Upon this (east) bank of the Willamette river ten miles south of Oregon City . . . is a small stream called Pole Alley (now Molalla) which is skirted with beautiful prairie bottoms two to eight miles in length and from one to two miles wide, . . . alternate with groves of fir. Half a mile further south . . . the valley up this (Pudding) river to the Cascades (mountains) is alternately fine prairie and timber lands, with occasional fern openings. It is finely clothed with grass. . . . Eight miles above (the mouth of) Pudding river is a village called Butes (now Butteville). Immediately at this village is a fern opening, covered with an undergrowth of hazel for three-fourths of a mile back, where it merges into an extensive and fertile prairie. . . . From the (Methodist) mission the road proceeds (southward) up the valley, alternately through groves of oak and pine, fern plains, and grassy prairies. . . . The (Willamette) valley at this place (Salem) is about twenty-five miles wide, . . . there are occasional groves of timber interspersing the prairie. The Santiam river banks (20 miles south of Salem) are covered with fir and white cedar of the best quality. This river has four principal branches with several small tributaries, all lined with timber, leaving a strip of beautiful prairie land between each two, from one-half to four miles in width. . . . After leaving the Santiam (southward), a prairie commences, of from four to twelve miles in width, which continues up the valley for a day's travel, I suppose about forty miles. The Willamette valley . . . is beautifully diversified with timber and prairie. The Willamette . . . river itself, throughout its length, has generally a (border) growth of fir and white cedar, averaging from one-fourth to three miles in width.''

As demonstrated by numerous descriptions, of which the foregoing excerpts are typical, the pioneers found the Willamette Valley to be a mixed grassland and timberland. There are numerous areas of timber today on land that has never been under the plow. Most of them were here as larger areas of smaller trees and bushes when the first white people came.

It is well known that soil scientists (Department of Soils, Oregon State College, in consultation) are able to distinguish between forest soils and grassland soils from the characteristics imparted to each by its former vegetative cover. They find here that most of the soils on relatively high elevations on the valley floor are forest soils and that most of those relatively lower and not so well drained have not been covered with timber, thus substantiating the recorded observations of the pioneers. Hence, a map of the natural vegetation of the Willamette Valley should show it as a grassland with a timber cover of less than one-half—probably about one-third or more—of the area of the valley floor.

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A Tree-Trunk Squeeze-Up in Lava

A squeeze-up is a lava mass which was forced upward, while still of semiliquid consistency, through an opening in the hardened surface crust of the flow. Several types of squeeze-ups have been reported by Nichols (*J. Geol.*, 1939, 47, 421–425) for the 220-square mile basalt flow of Recent origin south of Grants, Valencia County, New Mexico, which different authors have termed the Grants or McCarty's Lava Bed or the Aqua Fria Malpais.

An apparently undescribed type of squeeze-up is found in the eastern edge of the northwest lobe of this flow near the Ice Caves Resort, in Section 20 of the township which includes Paxton Springs. A few yards behind the resort headquarters building, near the southeast base of Flagpole Cone, are five or six vertical cylindrical holes in the lava, the largest 18″ in diameter and at least 5′ deep, the exact depth being obscured by accumulated rock fragments. These are popularly known as "devil's smokestacks." The tubes were produced by the flow of magma around standing tree trunks near the edge of the bed where the depth and pressure were relatively limited. No organic material remains, but one of the tubes has markings inside which strongly suggest a mold of the bark of yellow pine (*Pinus ponderosa*). Most of the tree tubes end flush with the rather smooth surface of the pahoehoe lava, but some show a low, weathered rim around the top of the tube, several inches above the general surface. The nature of the rim will be clearer from the following account.

One-tenth mile farther north along the flow's edge is found the best example of a tree tube, combined with an excellent example of a tree-trunk squeeze-up. The cavity is 110″ deep to the present bottom. The inside diameter of the tube averages 17″. A rock chimney readily seen from the Ice Caves branch road, projects 23″ above the horizontal lava surface. The diameter of the tube within the chimney is the same as that below the general surface. The thickness of chimney's wall ranges at different points from 7″ to 10″; the average is about 8″. The inside of the chimney is circular in cross section; the outside, of subcircular form. Close examination of the vertical wall and base of the chimney reveals parallel striations running vertically on the unweathered surface, which extends upward for a maximum distance of 10″. Above this basal portion, the chimney surface is weathered and irregular, and the broken top indicates that this peculiar hollow cylinder of lava once had a greater height. The external basal striations provide proof that the chimney originated as a squeeze-up. As the surface crust cooled and hardened, its shrinkage, in combination with the charring of the tree trunk's outer tissues, may have been sufficient to permit the soft viscous magma beneath to be squeezed between the remaining wood and the hard circular edge of the cooled crust. Irregularities in the latter left their marks formed as vertical striations during upward movement of the semiliquid ring. It is probable that for a chimney wall of such thickness to result, an additional factor was necessary—the removal of fragments from the edges of the crust by the pressure from beneath, widening the gap between the tree trunk and the firm crust.

Vertical ridges as much as ⅛ of an inch high occur sparsely on the inner surface of the tube proper below the chimney. These are connected by horizontal ridges, in lower relief, to form square markings. The latter are too regular in size and shape to be interpreted as the mold of tree bark. If it were not for a smaller secondary system of squares within the major system, there would be a superficial resemblance to the distinctive bark of alligator juniper (*Juniperus pachyphloea*) which grows in the immediate vicinity. The markings strongly suggest the "boxwork" found on the walls of certain caves, but with much lower relief than typical "boxwork." No explanation for the pseudo-bark markings can be offered. The Recent date of the flow, aridity of the climate, fissured and permeable character of the lava, and topography make it highly unlikely that this tube ever filled with water up to the level of the markings, 80″ from the bottom.

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Climatic Changes and Dark Nebulae

In the abstract of Donald H. Menzel's centennial symposium paper, "The Sun and the Earth," (*Science*, November 26, p. 590) there is a discussion of the possibility of climatic change being due to the passage of the solar system through dark nebulae or clouds of dust. The following statement is made: ". . . there is one other possibility to consider—a possibility that has not been previously suggested, to my knowledge." I wonder if Huntington and Visher did not discuss something similar to the above idea of climatic change in their book *Climatic changes* (Yale University Press, 1922, pp. 247–249).

WALDO S. GLOCK

Macalester College, St. Paul, Minnesota

In Memoriam

Joyce Clennam Stearns

1893–1948

Joyce Clennam Stearns died at his home in Webster Groves, Missouri, on June 11. He had served as director of the Metallurgical Laboratory at the University of Chicago during the last year of the war and since July 1945 had been dean of the Faculties of Washington University in St. Louis.

Stearns was born in Meadville, Missouri, in 1893, studied Liberal Arts at Kingfisher College, took his Master's and Doctor's degrees in physics at the University of Chicago, and taught successively at Albion College and the University of Denver, where he was professor and eventually chairman of the Department of Physics. In the field of teaching, few physicists have earned as high a reputation as did Dr. Stearns. He was among the first to be drawn to Chicago in January 1942, when the atomic program was set up as an active war project.

The climax of his professional career was at Washington University, where, as dean of the Faculties he was the guiding spirit in rebuilding the staff after the disruption of the war.

Stearns' first major scientific work was a demonstration that magnetization of iron makes no considerable change in the positions of the atoms or the electrons of which the iron is composed. This result ruled out the older theory of magnetism, based upon the Bohr atom, according to which the electrons revolving in orbits constituted the elementary magnets that were oriented by the applied magnetic field. It was consistent, however, with the later theories according to which the electrons are themselves magnets that become oriented when the iron is magnetized. Stearns' experiment consisted of magnetizing a crystal of iron from which a beam of X-rays was reflected. He found that no change in the strength of the reflected beam as great as one part per thousand was caused by magnetization, whereas changes of several per cent should have been expected if the orbits in which the electrons revolved had followed the magnetic field.

Stearns also carried on several interesting experiments with cosmic rays, including tests of possible directional effect from the sun and of east-west asymmetry of cosmic-ray showers. His most notable achievement in cosmic-ray studies, however, was his establishment of the high-altitude laboratory on Mt. Evans, just west of Denver. Stearns secured the cooperation of the Denver City Parks in building a road to the top of the mountain and in preparing the site, and persuaded the University of Denver, Massachusetts Institute of Technology, and the University of Chicago to cooperate with Mr. John Evans in building and maintaining the laboratory. He gave valuable aid to the many expeditions to Mt. Evans from several universities by offering his own laboratory at Denver as a low-altitude base of operations and by helping with the experiments in many ways. It would be a fitting tribute, indeed, to name the Mt. Evans laboratory after him.

ARTHUR H. COMPTON
Washington University, St. Louis

* * *

(*Continued from page 30.*)

any aspect of human emotional-mental-social development, whoever can do something to clarify thinking even a little and very locally, whoever can help to remove a prejudice, soften a hate, increase the total of understanding and tolerance in the world, by that knowledge, training, insight, or ability is made responsible to do what he can in all possible places. Research is valuable but may remain sterile for long periods, and time is short. Erudite papers read to technical gatherings and published in technical journals have their important place, but may be futile unless appropriate action follows. Responsibility of the informed and technically qualified is to all people, not just to the enlightened.

The really noble example given by Kurt Lewin should continue to be an inspiration. His work and enthusiasm will continue to contribute greatly to present and future developments in the field of human relations. Some part of it can be carried on by every one of us.

Whoever can get at people in homes or schools or universities, in Parent-Teacher Associations, in Home and School Clubs, in youth groups, in churches or service clubs, by talking or writing, through lectures, radio, newspapers, magazines, books, or any other channels of communication, is obligated, by his ability, to serve the human race where he can to the limit of his equipment. Dare any of us say that he or she can do nothing about the desperate need of the world for better human relations?

Book Reviews

Mikro-Methoden: zur Kennzeichnung organischer Stoffe und Stoffgemische. Ludwig Kofler and Adelheid Kofler. Innsbruck, Austria: Universitäts-Verlag-Wagner, 1948. Pp. viii + 337. (Illustrated.) $9.00.

The methods used for characterizing the organic substances described in this book are based on observations of the melting, decomposition, and sublimation points, and refractive indices under the microscope. While this technique is familiar to most chemists, the authors are able to point out many refinements of the established methods. A theoretical discussion of melting-point diagrams is followed by their application to the qualitative and quantitative analysis of mixtures and the molecular weight determination. The authors stress the importance of the determination of the refractive index under the microscope, enabling the experimenter to establish, in a short time and with simple means, a physical constant at temperatures which often forbid the use of ordinary refractometers. With 16 glass powders, with refractive indices ranging from 1.3400 to 1.6718, the index of refraction can be determined with an accuracy of 0.0004.

The tables of a thousand organic substances listing eutectic temperatures (with phenacetin and benzanilide as one of the components), refractive indices, and melting, decomposition, and sublimation temperatures make this book useful on the laboratory shelf. The tables are followed by a valuable, extensive literature list with many references to journals unfamiliar to most American readers. The many diagrams and clear presentation make the book excellent reading material and will undoubtedly give many a stimulating thought to those spending much time in front of the melting-point apparatus.

A. J. HAAGEN-SMIT

California Institute of Technology

Industrial electronics reference book. (Contributions of Electronics Engineers of the Westinghouse Electric Corp.) New York: John Wiley; London: Chapman & Hall, 1948. Pp. x + 680. (Illustrated.) $7.50.

As stated in the Introduction, this book serves as a "digest embracing the applications as well as the design data for industrial electronic equipment." This assignment is admirably fulfilled, since the book contains many excellent graphs, tables, and illustrations on materials and industrial equipment. As a reference book it is necessarily brief in theoretical topics except in the chapters on transmission lines and antennas, whose direct relation to industrial equipment is perhaps not immediately obvious.

The 36 chapters are arranged to form specific groups. The first 4 chapters cover basic information on electrons, their emission, motion in vacuum, and interactions with ions in gas conduction. Chapters 5–10 cover electron tubes of various designs: vacuum, gas, photoelectric, X-ray, cathode-ray, and tubes for ultraviolet production; several of these chapters have very extensive reference lists. Four chapters follow on circuit elements including filters, transformers, and tubes, and the next four chapters describe circuits as used in conjunction with rectifiers, amplifiers, oscillators, and basic control.

Chapters 21 through 34 deal primarily with industrial applications and equipment, e.g. rectifiers and inverters, R. F. heating (taken from a previously published handbook), industrial X-ray application, precipitation, applications of ultraviolet, power line carrier communication, electronic instruments (109 references), and radar. Chapters 29 through 32 deal with individual phases of control applied to motors, generators, welding, etc.

The final two chapters give information on the care and maintenance of electronic equipment.

The book has been well edited, with consistent numbering of subheadings and excellent print. All the authors are well known through other publications. Without doubt this book fills a gap which existed too long; it will prove of great help to practicing engineers and as reference material for advanced courses in industrial electronics.

ERNST WEBER

Polytechnic Institute of Brooklyn

Drug research and development. Austin Smith and Arthur D. Herrick. (Eds.) New York: Revere, 1948. Pp. xi + 596. $10.00.

In the first chapter one finds a statement which conveys the spirit of this book: "The discoveries and inventions in this sphere, merely in the last fifteen years, have contributed more to the happiness, well-being, and health of humanity than has any other advancement." After that lofty beginning the reader is immediately brought down to earth and given a thorough understanding of what is required to achieve and maintain this advancement. The physician, drug manufacturer, research and laboratory worker, pharmacist, detail man, executive, production and control worker, attorney, the professor educating practical men, and the man on the job can all see, in perspective, their part in this achievement. All can read with much profit and will doubtless find it a valuable reference book.

The authors of the various chapters have all had long experience with the topics they discuss. This would seem to guarantee the reliability of the mass of practical information presented. These authors are from industry, universities, and the professions and in many instances have presented information which must have cost them much to acquire. Some of the topics covered are laboratory research, development of biologicals, clinical testing, development of facilities and controls, labels and labeling, packaging and storing, patent law, trade-marks and labels, drug regulation, new drug application, biologic control regulation, drug certification, council acceptance, product development promotion and marketing, advertising, detailing the physician, professional acceptance, and retail price maintenance. A valuable bibliography is also included.

The book is not without surprises. Actually the word "research" is appropriate to the title by courtesy only, for few chapters are allocated to that topic and then, of necessity, from the viewpoint of the drug industry. While it may be admitted that this apportionment of research to the total picture is appropriate, devoted researchers like to think their contribution represents a far greater portion of the total. One chapter unexpectedly contains an excellent discussion of the critical need for animal experimentation, and another contains invaluable advice to medical copywriters. Occasionally one finds certain details emphasized more than once. For example, at four different places the laboratory worker is advised to keep a record to provide legal evidence of work accomplished; tests on stability of drugs are discussed twice. The risks and returns on research investment are discussed four times and not without conflicting viewpoints. Perhaps this serves to emphasize that the editors have extended the utmost latitude and liberty to each author in expressing his thoughts.

Walter H. Seegers

Wayne University

Scientific Book Register

Baver, L. D. *Soil physics.* (2nd ed.) New York: John Wiley: London: Chapman & Hall, 1948. Pp. xiii + 398. (Illustrated.) $4.75.

Bremekamp, C. E. B., and Nannenga-Bremekamp, N. E. *A preliminary survey of the Ruelliinae (Acanthaceae) of the Malay Archipelago and New Guinea.* (Nederl. Akad. Wet., Verh. (Tweede Sectie), Dl. XLV, No. 1.) Amsterdam: N. V. Noord-Hollandsche Uitgevers-Maatschappij, 1948. Pp. 39.

Gates, H. A. *Primary anatomy.* Baltimore: Williams & Wilkins, 1948. Pp. ix + 478. (Illustrated.) $6.00.

Churchill, Ruel V. *Introduction to complex variables and applications.* New York-London: McGraw-Hill, 1948. Pp. vi + 216. (Illustrated.) $3.50.

Davis, Joseph S. (Ed.) *Carl Alsberg: scientist at large.* Stanford, Calif.: Stanford Univ. Press, 1948. Pp. xi + 182. $2.00.

Findlay, Alexander. *A hundred years of chemistry.* (2nd ed.) Cambridge, Engl.: at the Univ. Press; New York: Macmillan, 1948. Pp. 318. $4.50.

Fleury, Paul, and Courtois, Jean. *Les diastases.* Paris: Librairie Armand Colin, 1948. Pp. 216. 150 fr.

Henson, Francis Roger Spencer. *Larger imperforate Foraminifera of south-western Asia: families Lituolidae, Orbitolinidae and Meandropsinidae.* London: British Museum (Natural History), 1948. Pp. xi + 127. (Illustrated.) 1£ 10/.

Hoskins, Margaret M., and Bevelander, Gerrit. *Outline of histology.* Pt. I: *General histology;* Pt. II: *Dental histology and embryology.* (2nd ed.) St. Louis, Mo.: C. V. Mosby, 1948. Pt. I: 180 pp.; Pt. II: 113 pp. (Looseleaf.) (Illustrated.) $3.50.

Kabat, Elvin A., and Mayer, Manfred M. *Experimental immunochemistry.* Springfield, Ill.: Charles C. Thomas, 1948. Pp. xv + 567. (Illustrated.) $8.75.

Keenan, Joseph H., and Kaye, Joseph. *Gas tables: thermodynamic properties of air products of combustion and component gases and compressible flow functions.* (Rev. ed.) New York: John Wiley; London: Chapman & Hall, 1948. Pp. x + 238. $5.00.

Konorski, Jerzy. *Conditioned reflexes and neuron organization.* Cambridge, Engl.: at the Univ. Press; New York: Macmillan, 1948. Pp. xiv + 267. (Illustrated.) $4.00.

Lief, Alfred. *The commonsense psychiatry of Dr. Adolf Meyer: fifty-two selected papers edited, with biographical narrative.* New York-London: McGraw-Hill, 1948. Pp. xvii + 677. (Illustrated.) $6.50.

Loveridge, Arthur. *New Guinean reptiles and amphibians in the Museum of Comparative Zoölogy and United States National Museum.* (Bull. of Museum of Comparative Zoology, Harvard, Vol. 101, No. 2.) Cambridge, Mass.: Museum of Comparative Zoology, 1948. Pp. 307–430.

Needham, Joseph, and Needham, Dorothy. (Eds.) *Science outpost: Papers of the Sino-British Co-operation Office, 1942–1946.)* London: Pilot Press, 1948. Pp. 313. (Illustrated.) 25/.

Patty, Frank A. (Ed.) *Industrial hygiene and toxicology.* (Vol. I.) New York-London: Interscience, 1948. Pp. xxvii + 531. (Illustrated.) $10.00.

Pincus, Gregory, and Thiman, Kenneth V. (Eds.) *The hormones: physiology, chemistry and applications.* (Vol. I.) New York: Academic Press, 1948. Pp. xi + 886. (Illustrated.) $13.50.

Raisz, Erwin. *General cartography.* (2nd ed.) New York-London: McGraw-Hill, 1948. Pp. xv + 354. (Illustrated.) $6.00.

Stevens, Neil E. *Factors in botanical publication and other essays.* (Vol. 11, No. 3.) Waltham, Mass.: Chronica Botanica; New York: Stechert-Hafner, 1947. Pp. 119–206. $2.00.

Thirring, Hans. *Die Idee der Relativitätstheorie: gemeinverständlich dargestellt.* (3rd ed.) Wein, Austria: Springer Verlag, 1948. Pp. 168. $2.80.

Wedel, Waldo R. *Prehistory and the Missouri Valley development program: summary report on the Missouri River Basin Archeological Survey in 1947.* (Smithsonian Misc. Coll., Vol. III, No. 2.) Wash., D. C.: Smithsonian Institution, 1948. Pp. 52. (Illustrated.)

Woerdeman, M. W. *Atlas of human anatomy: descriptive and regional.* Baltimore, Md.: Williams and Wilwins, 1948. (Illustrated.)

———. *Les isotopes: rapports et discussions.* (Septième Conseil de Chimie; Institut International de Chimie Solvay.) (In French and English.) Brussels: R. Stoops, 1948. Pp. 411. (Illustrated.)

NEWS and Notes

Norman H. Topping, associate director of the National Institutes of Health, was recently appointed Assistant Surgeon General of the U. S. Public Health Service. Dr. Topping will continue to serve as associate director of the Institutes.

C. R. Orton, dean of the College of Agriculture, Forestry, and Home Economics and director of the Agricultural Experiment Station of West Virginia University, will resign from his administrative duties next June to engage in research and teaching in the Department of Plant Pathology.

Ford L. Wilkinson, Jr., former dean of the U. S. Naval Postgraduate School, Annapolis, became president of Rose Polytechnic Institute, Terre Haute, Indiana, on January 1, succeeding **Donald B. Prentice** who retired last July.

Emil J. Hellund, associate professor of physics at the University of Oklahoma, has joined the staff of the Theoretical Nuclear Physics Division, Argonne National Laboratory, as a senior physicist.

Mary Baeyertz has been named assistant chairman of the Metals Research Department, Armour Research Foundation of Illinois Institute of Technology. In her new position Dr. Baeyertz will assist Mr. Mahin, chairman of the Department, in general scientific supervision of fundamental and applied research programs for industry and government agencies.

J. Lawrence Pool was recently appointed director of the neurological surgery service at the Neurological Institute of Presbyterian Hospital as well as professor and executive officer of the Department of Neurological Surgery, Columbia University Faculty of Medicine. Dr. Pool has been associated with the Columbia-Presbyterian Medical Center since 1932.

George R. Ringo has been appointed an associate physicist on the staff of the Experimental Nuclear Physics Division of the Argonne National Laboratory. Dr. Ringo had been with the Naval Research Laboratory for the past 7 years.

Edward M. Bernecker, former commissioner of hospitals of New York City, has been appointed administrator of hospital services of the New York University-Bellevue Medical Center, effective January 1. In his new position Dr. Bernecker will be responsible for the administration of University Hospital, the Institute of Rehabilitation, and the various University clinics as well as for the coordination of the clinical teaching programs in other hospitals associated with the Medical Center.

G. Goussef, chef d'Aquarium, Musée de la France d'Outremer, 293 Avenue Daumesnil, Paris 12, will be happy to exchange publications with American workers in the field of hydrobiology and allied sciences.

Paul L. Munson has resigned as head of endocrinology research for Armour and Company, Chicago, to accept an appointment as research assistant professor in the Department of Pharmacology, Yale University School of Medicine.

Gilbert B. L. Smith and **Sol Skolnik** have been appointed head of the Chemistry Division and acting head of the Inorganic Chemistry Section, respectively, in the Research Department, U. S. Naval Ordnance Test Station, Inyokern, China Lake, California. **Harold F. Metcalf** has been made scientific staff assistant to Dr. Smith.

Robert G. Gibbs, former special agent of the Federal Bureau of Investigation, has been made associate editor of *Chemical and Engineering News* and *Industrial and Engineering Chemistry*, publications of the American Chemical Society.

Raymond E. Cray has been appointed professor in the Department of Poultry Science of the Ohio State University College of Agriculture, effective March 28.

George E. Ziegler, acting administrative chief of the Midwest Research Institute, Kansas City, Missouri, since the resignation of Harold Vagtborg 6 months ago, has been made director; **Clayton O. Dohrenwend** has been appointed assistant director of the Institute.

J. A. Salzmann, head of the Department of Orthodontics, Mt. Sinai Hospital, New York City, will leave March 20 for a lecture tour of Mexico, Brazil, and Argentina. The tour is being made at the invitation of Mexican and Brazilian dental societies and by official invitation of the Argentine Government.

Grants and Awards

Brig. Gen. James Stevens Simmons, U. S. Army, Retired, dean of the Harvard School of Public Health, was recently presented the alumni Citation of Merit by John Cunningham, president of Davidson College. At the Convocation Assemblage Gen. Simmons was cited for outstanding contributions in the fields of preventive medicine and public health.

The Research Council on Problems of Alcohol has made grants of $2,500 each to the Biochemical Institute of the University of Texas and to the University of Washington Medical School. The grant to the Biochemical Institute will be used to continue investigations, under the direction of Roger J. Williams, on possible physiological causes underlying problem drinking and that to the University of Washington will support work by Walter L. Voegtlin in the determination of allergic factors underlying chronic alcoholism.

The Woman's Medical College, Philadelphia, has received a grant of $37,302 under the National Mental Health Act for developing psychiatric training for undergraduate medical students. The funds will be made available for the academic year 1949–50 and be paid in annual allotments over a three-year period.

The American Foundation for High Blood Pressure recently awarded grants for research in hypertension and arteriosclerosis to the following: Thomas C. Barnes, Hahnemann Medical College; Stanley E. Bradley, Columbia University; Norman E. Freeman, Franklin Hospital, San Francisco; Meyer Friedman, Mt. Zion Hospital, San Francisco; Sydney M. Friedman, McGill University, Faculty of Medicine; David M. Greenberg, University of California, Berkeley; Keith S. Grimson, Duke University Hospital; Albert I. Lansing, Washington University School of Medicine; Arnold Lazarow and J. W. Patterson, Western Reserve University; Jessie Marmorston, University of Southern California; Campbell Moses, University of Pittsburgh School of Medicine; Frederick J. Moore and Norman C. Flau, University of Southern California; Jean Oliver, Long Island College of Medicine; Ernest W. Page, University of California Medical School; Lelland J. Rather, Stanford University School of Medicine; G. F. Wakerlin, University of Illinois; A. Earl Walker, Johns Hopkins University; Harold Wiggers, Albany Medical College; and Eugene Ferris, University of Cincinnati.

Fellowships

The National Research Council of Canada has announced that about 40 postdoctorate fellowships are available in 1949–50 for research in pure chemistry and physics in NRC laboratories at Ottawa and in the laboratories of the Atomic Energy Project at Chalk River, Ontario. The majority of these will be in chemistry and physics although a few have been assigned to atomic energy research. The fellowships are awarded for one year but may be renewed. They carry a stipend of $2,820, free of income tax, and an additional grant will be made for the expenses of those coming from abroad. There is no nationality restriction for the positions in the Ottawa laboratories; however, those at Chalk River are limited to British subjects. Applications should be made to the National Research Council, Ottawa, Canada, not later than *March 1*, 1949.

The Sigma Delta Epsilon Research Fellowship in Science is again being offered this year. This predoctoral fellowship, which carries a stipend of $1,200, is awarded to women who give evidence of outstanding ability and promise and who need financial assistance to further a well-defined research project in the mathematical, physical, or biological sciences. Application blanks, which must be submitted before *February 1*, may be obtained from Dr. Virginia Bartow, 7 Chemistry Annex, University of Illinois, Urbana, Illinois. Announcement of the award will be made early in March.

The Institute of Gas Technology at Illinois Institute of Technology will accept applications for fellowships until *March 15*, 1949. Fifteen fellowships, each carrying a stipend of $125 per month for ten months, with increases in the following months, are available. Seniors and graduates under 28 years of age, who have backgrounds in chemistry, chemical engineering, mathematics, mechanical engineering, and related fields, are eligible. Applications should be addressed to the Director, Institute of Gas Technology, Technology Center, Chicago 16.

Colleges and Universities

A new measurement of the distance of the earth from the sun, based on more than 5,000 observations of the moon, was reported by Dirk Brouwer, director of the Yale University Observatory, at the meeting of the American Astronomical Society in New Haven the last week in December. The computations show the distance to be 92,960,000 miles, subject to an uncertainty of not more than 35,000 miles. The project was begun by the late Ernest W. Brown, professor of mathematics at Yale, and from 1932 through 1942, 5,100 observations were made from 200 locations over the world, data from which were sent to Yale Observatory. This system of measurement is based on the gravitational pull of one body upon another —in this case of the sun upon the moon.

The University of Minnesota, Duluth Branch, has announced the following staff appointments: Raymond W. Darland, formerly of the University of Nebraska, associate professor of botany; Moses Passer, formerly of Cornell University, assistant professor of chemistry; Herbert C. Nelson, consulting engineer, instructor in civil engineering; Samuel Weiner, former research chemist for the Paul-Lewis Laboratories, assistant professor of chemistry; and Harlan D. Fayle, former instructor at Duluth Junior College, instructor of chemistry.

"The Physical Chemistry of Large Molecules" will be the subject of the new Wayne University "Frontiers of Chemistry" series scheduled for early 1949. Planned especially for those interested in the fields of rubber, plastics, proteins, and other materials of complex molecular structure, the series will feature lectures by prominent scientists on successive Monday evenings. The University Chemistry Department and the International Society of the Friends of the Kresge-Hooker Library are jointly sponsoring the symposium.

Paul J. Flory of the Cornell University Chemistry Department will be the speaker for the initial program on February 28. His subject will be "Thermodynamics of Polymer Solutions." Subsequent lectures will be: March 7 — Robert Simha, National Bureau of Standards, "Viscosity of Solutions of Large Molecules"; March 14—Raymond Fuoss, Sterling Chemical Laboratory, Yale University, "The Physical Chemistry of Polyelectrolytes"; March 21 — Raymond Boyer, Dow Chemical Company, "Structure and Properties of Polymer Gels"; March 28—Hubert M. James, Purdue University, "Theory of the Elasticity of Rubber-like Materials"; April 4—Henry B. Bull, College of Medicine, Northwestern University, "Physical Chemistry of Protein Hydrolysis"; April 11—John T. Edsall, Harvard Medical School, "Size, Shape, and Molecular Configuration of Protein Molecules"; April 25—Max A. Lauffer, Physics Department, University of Pittsburgh, "Physical Chemistry of Viruses."

Graduate credit for the lecture series will be available to qualified registrants. Those interested in attending on a noncredit basis may obtain information from J. Russell Bright, Department of Chemistry, Wayne University, Detroit.

Fire has completely destroyed the building housing the School of Medicine and the Department of Parasitology of the University of Chile. All equipment and a library which contained 10,000 reprints on parasitology, tropical medicine, and rural health have been lost. Readers of *Science* having reprints available on these subjects who would like to assist in the reconstruction of the library may address material to Amador Neghme R., Professor of Parasitology, University of Chile, P. O. Box 9183, Santiago, Chile.

Meetings and Elections

A Symposium on Recent Research in Food and Milk Sanitation, under the sponsorship of the Sanitation Study Section, Division of Research Grants and Fellowships, U. S. Public Health Service, will be held January 26–27 in Washington, D. C., in the Department of Commerce Auditorium. Current research in bacteriology, epidemiology, entomology, veterinary medicine, etc. will be discussed by specialists from various governmental agencies, colleges, and universities. Registration will take place at 9 A. M. Thursday and the first meeting will begin at 10 A. M.

The Metropolitan Microchemical Society of New York is sponsoring a symposium at the American Museum of Natural History, New York City, February 25–26. The program has been planned to stimulate further interest in the field of microchemistry, and the public is invited to attend. The flame photometer, radioactivity in microanalysis, determinations of traces of elements, instrumentation, application of electrochemistry to the analysis of small amounts of material, and the ultracentrifuge will be topics of discussion. Those wishing to attend the Friday evening dinner and the Saturday afternoon luncheon, both at the Hotel Bolivar, should send their reservations to the chairman, Al Steyermark, Hoffmann-La Roche, Inc., Nutley 10, New Jersey, not later than February 17.

The Ecologists Union, devoted to the preservation of natural biotic communities for scientific use, has elected the following officers by mail ballot: president, A. O. Weese, University of Oklahoma; vice-president, F. W. Albertson, Fort Hays Kansas State College; member of the Board of Governors, Richard H. Pough, American Museum of Natural History. Ralph W. Dexter, Kent State University, continues as secretary-treasurer.

The Committee on the Study of Plant and Animal Communities, under the chairmanship of S. Charles Kendeigh, University of Illinois, will publish in the near future an inventory of nature sanctuaries in North America. The Committee for the Preservation of Natural Conditions, with Curtis L. Newcombe, Cranbrook Institute of Science, as chairman, has given support this past year to protection of natural areas in Massachusetts, Pennsylvania, and Iowa as well as Federal projects of conservation, particularly for the creation of a National Grassland Monument and support for the Blatnik-Thye Bill, H.R. 6240 and S. 1090, as a step toward the creation of a Quetico-Superior National Park.

A meeting of the American Society for X-Ray and Electron Diffraction took place at Battelle Memorial Institute, Columbus, Ohio, December 16–18. The scientific sessions included a number of papers featuring microtechniques. The proposed plan for a single society to take the place of the ASXRED and the Crystallographic Society of America was discussed in the business meeting. The group was addressed at dinner by Max von Laue.

The Nebraska Section of the American Chemical Society has elected its officers for 1949. They are: H. T. Bates, president; Bennet D. Hites, vice-president; and Henry F. Holtzclaw, Jr., secretary-treasurer. All are associated with the University of Nebraska.

The Division of Gas and Fuel Chemistry of the American Chemical Society has elected the following new officers: G. Robert Yohe, head of the Coal Division of the Illinois State Geological Survey, chairman, to succeed Calvert C. Wright, chief of the Division of Fuel Technology of the Pennsylvania State College School of Mineral Industries; Ralph E. Brewer, of the U. S. Bureau of Mines, Pittsburgh, chairman-elect; and H. Beecher Charmbury, of Pennsylvania State College, secretary-treasurer (a re-election). Dr. Yohe and Dr. Wright represent the Division on the Society's National Council, and Dr. Brewer and Henry Hakewill, Jr., of the Institute of Gas Technology, Chicago, are the alternate councilors.

The Division of Rubber Chemistry, American Chemical Society, has elected Howard I. Cramer, director of development, Sharples Chemicals, Inc., Philadelphia, chairman, and Frederick W. Stavely, director of research, Firestone Tire & Rubber Company, Akron, chairman-elect. Charles R. Haynes, manager of rubber service, Binney & Smith Company, New York, and C. W. Christensen, sales manager of the Rubber Service Laboratories, Monsanto Chemical Company, Akron, were re-elected secretary and treasurer, respectively. Harry E. Outcault, manager of zinc oxide sales, St. Joseph Lead Company, New York, former chairman, has now become a member of the Division's board of directors.

The International Institute of Embryology has elected the following American scientists to membership: Howard B. Adelmann, Cornell University; L. G. Barth, Columbia University; Donald P. Costello, University of North Carolina; S. R. Detwiler, Columbia University; R. M. Eakin, University of California, Berkeley; Gerhard Fankhauser, Princeton University; V. Hamburger, Washington University; E. B. Harvey, Princeton University; Arthur T. Hertig, Boston University; Chester H. Heuser, Carnegie Institute; Leigh Hoadley, Harvard University; J. S. Nicholas, Yale University; A. Mandel Schechtman, University of California, Los Angeles; L. S. Stone, Yale University; Victor C. Twitty, Stanford University; Albert Tyler, California Institute of Technology; Paul Weiss, University of Chicago; B. H. Willier, Johns Hopkins University; E. Witschi, State University of Iowa; and L. F. Yntema, Cornell University.

The incorporators of the Scientific Research Society of America, a new national scientific research society, announced the election of the following officers and Board of Governors November 27 at their Cleveland convention: chairman, George A. Stetson, editor of publications of the American Society of Mechanical Engineers; director, Donald B. Prentice, past-president, Rose Polytechnic Institute; treasurer, George A. Baitsell, executive secretary, Society of the Sigma Xi; members of the Board, Joseph W. Barker, president, Research Corporation, New York City; W. V. Houston, president, Rice Institute, Houston, Texas; M. C. K. Jones, Esso Research Laboratories, Elizabeth, New Jersey; William Procter, Palm Beach, Florida; George A. Stetson; C. G. Suits, director, Research Laboratory, General Electric Company, Schenectady, New York; C. A. Thomas, executive vice-president, Monsanto Chemical Company, St. Louis, Missouri; William E. Vaughan, Shell Development Company, Emeryville, California; and Edward R. Weidlein, director, Mellon Institute, Pittsburgh, Pennsylvania; and members of the Board, ex officiis, Carl D. Anderson, president, Sigma Xi; George A. Baitsell; and George B. Pegram, treasurer, Sigma Xi. The national headquarters has been established at 54 Hillhouse Avenue, Yale University, New Haven, Connecticut.

NRC News

The Division of Geology and Geography has available three new publications.

"The Rock-Color Chart" ($5.50), especially designed for field use, but also suitable for office or laboratory, includes 115 colors which indicate the range of rock colors for all purposes and a brief text explaining the systems used for the chart arrangement and color names. The Munsell sytsem has been used for form and arrangement, and color names have been taken from the ISCC-NBS system. The Munsell numerical designation is also given for each color chip. The chart was prepared by the Rock-Color Chart Committee, a Subcommittee of the Committee on Symposium on Sedimentation, including E. N. Goddard, U. S. Geological Survey; Parker D. Trask, Geological Society of America; Ronald K. DeFord, American Association of Petroleum Geologists; Olaf N. Rove, Society of Economic Geologists; and Joseph T. Singewald, Jr., and R. M. Overbeck, both of the Association of American State Geologists.

A "Report of the Committee on the Measurement of Geologic Time, 1946–1947, Inclusive" ($1.00) includes reports and articles by John Putnam Marble, chairman of the Committee, Arthur Holmes, University of Edinburgh, L. H. Ahrens, Alfred C. Lane (chairman of Committee until July 1946), and R. F. Beers.

Another publication, "Report of the Committee on a Treatise on Marine Ecology and Paleoecology, 1946–1947" ($1.00), prepared under Harry S. Ladd, chairman, and Kenneth E. Lohman, vice-chairman, includes reports and sections on current activities, recently published papers, completed units of annotated bibliographies of Marine Ecology and Paleoecology, and several articles.

Copies may be obtained from the Division headquarters at the National Research Council, 2101 Constitution Avenue, Washington 25, D. C.

The Committee on Research in Endocrinology has announced that requests for grants-in-aid during the fiscal year, July 1, 1949–June 30, 1950, will be received until *February 28.* Work in the general fields of experimental and clinical endocrinology as well as studies of the effect of sex hormones on nonsexual functions, such as general metabolism and the metabolism of steroid hormones, will be considered. Investigators seeking support for research in the problems of sex in the narrower sense, however, should direct their proposals to the Committee for Research in Problems of Sex rather than that on Endocrinology. Applicants must submit a statement of the problem and plan and information regarding the method of attack, the institutional support of the investigation, and the uses to which the grant will be put. The funds may not be used by the recipient institution for administrative expenses. Blanks may be obtained from the Secretary, Division of Medical Sciences, National Research Council, 2101 Constitution Avenue, Washington 25, D. C.

Deaths

Robert Stephen Briffault, 72, British surgeon, anthropologist, and author, died December 11 in Hastings, England.

Arial W. George, 66, a pioneer radiologist, died December 24 in Brookline, Massachusetts. Dr. George was one of the first Americans to receive the Sir James Mackenzie-Davidson Memorial Medal of the British Royal Society of Medicine in recognition of his application of Roentgen rays to disease diagnosis.

Frank Irwin, 80, professor emeritus of mathematics at the University of California, died December 25 in Berkeley, California.

Samuel J. Plimpton, 65, professor of physics at Worcester Polytechnic Institute, died December 29 at Worcester, Massachusetts.

Edward S. Johnson, 86, chemical research consultant for the drug, dye and explosives industries, died December 30 in New Rochelle, New York.

A. Herman Pfund, 69, professor emeritus of physics at Johns Hopkins University and former president of the American Optical Society, died January 4 in Baltimore, Maryland.

Two seed packages can now be ordered through CARE for delivery in Austria, Belgium, Czechoslovakia, Finland, Italy, France, Greece, the Netherlands, Poland, Great Britain (England, Scotland, Wales, Northern Ireland) and the American, British, and French Zones of Germany and Berlin. For family use, a package contains enough seeds to plant a garden *50′ × 150′ and to yield fresh* vegetables throughout the summer months as well as those suitable for canning and storage for use next winter. The other package contains 20 lbs of hybrid field corn seed, enough for planting 2½ acres. The latter may be harvested for feed for fattening meat animals or for maintaining a high level of production in dairy cattle. Complete instructions in the appropriate language are included in each package. The packages may be ordered, at $4 each, from CARE, 50 Broad Street, New York City 4, or from CARE outlets in several of the major cities.

The U. S. Civil Service Commission has announced an examination for Physical Science Administrators, $5,232 to $10,305 per annum, for positions in Washington, D. C., and vicinity. Applicants must have completed a 4-year college course majoring in physical science, mathematics, or engineering; an equivalent in technical experience; or an appropriate combination of the two. At least three years of professional experience which has included or been supplemented by administrative experience in fields of physical science is also required. No written test will be given. Information and application blanks may be obtained from the U. S. Civil Service Commission, Washington 25, D. C.

Libraries in devastated countries may now subscribe to *Psychometrika*, the quarterly journal of the Psychometric Society at a special reduced rate of $3.00. The usual subscription rate it $10.00. According to Albert K. Kurtz, secretary of the Psychometric Corporation, the Board of Directors has authorized this policy for 1949 on an experimental basis. Libraries wishing to take advantage of this offer should send checks, payable to the Psychometric Corporation, to Edward E. Cureton, Treasurer, 853, East Brewster Road, Alcoa, Tennessee.

The National Registry of Rare Chemicals, 35 West 33rd Street, Chicago 16, Illinois, has announced the following list of wanted chemicals: pentazine; myristicinaldehyde; D- and L-xyloketose; 6-menthen-2-ol; carbonyl sulfide; 3-tropanone; 2-amino-5-hydroxy-n-valeric acid; urobilinogen; melissyl alcohol; 5-hydroxy-1,4-naphthaquinone; thymidine; adonidin; isovanillin; coumingine; gelseminine; harmine hydrochloride; zinc carbonyl; titanium difluoride; cevadine; and germanium dichloride.

The Third Michigan International Exhibition of Nature Photography, under the sponsorship of the Cranbrook Institute of Science and several Michigan nature societies, has been scheduled for the period March 26–April 3 at the Detroit Flower Show, and for the period April 5–15 at the Cranbrook Institute. All student, amateur, and professional photographers here and abroad (the entry fee may be waived for exhibits from foreign countries from which it is impossible to send money) are invited to submit nature pictures in competition for either the print or transparency groups. The exhibits will usually fall into one of the following categories: I. Zoological—all animals (except pets), birds, fish, reptiles, insects, etc; animal products such as corals, shells, fossils, bones, nests, etc; II. Botanical—plants, trees, flowers, mosses, shrubs, fungi, etc; III. Scenery—where emphasis is on geological aspects and natural phenomena; and IV. Micro and macro photographs of any natural science subject. In addition to the first, second, and prize ribbons, special awards will be given for exhibits on fresh-water algae; ferns; minerals; insects; astronomy; birds; mammals; and flowers. Particulars may be obtained by writing to Roger E. Richard, Chairman, P. O. Box 2411, Dearborn, Michigan. The deadline for receipt of entries of *March 14*, 1949.

The National Council of the American Institute of Chemists has passed the following Resolution:

WHEREAS, Congressional Investigating Committees can produce results of great value to the country and,

WHEREAS, The value of their work depends on an impartial uncovering of facts and,

WHEREAS, Their ability to obtain valuable and useful information is lessened by premature public statements unsubstantiated by proof and,

WHEREAS, Such premature public statements may cause injustice to be done to American citizens, and may endanger national security,

Therefore, be it *Resolved*, That the American Institute of Chemists, acting through its National Council, urges that Congressional Investigating Committees proceed with judicial restraint and with due regard for the rights of all witnesses.

The American School of Prehistoric Research, located at the Peabody Museum of Harvard University, Cambridge 38, Massachusetts, recently announced the appearance of Bulletin 16, "The Neolithic Period in Bulgaria," by the late James Harvey Gaul. This illustrated publication (253 pp.) is a study of the earliest food-producing cultures of eastern Europe and of the connections of that area with Neolithic Greece. Although the monograph cost $7.00 to produce, the School is offering it to interested individuals and institutions at $4.75. Several other important manuscripts are awaiting publication.

Make Plans for—

American Institute of Electrical Engineers, winter general meeting, January 31–February 4, Hotel Statler, New York City.

National Conference on Rural Health, February 4–5, Palmer House, Chicago, Illinois.

International Geographical Union, 16th Congress, April 8–15, Lisbon, Portugal.

5th International Congress for Comparative Pathology, May 17–20, Istanbul, Turkey.

Recently Received—

Light on a medical mystery. Educational pamphlet of the National Multiple Sclerosis Society, New York Academy of Medicine Building, Fifth Avenue and 103rd Street, New York City 29.

College Board Review. Published quarterly by the College Entrance Examination Board, 425 West 117th Street, New York City 27.

Mental Hygiene News. Published monthly except July and August by the New York State Department of Mental Hygiene through the State Hospitals Press, 1213 Court Street, Utica, New York.

The Institute News. Printed and published by the Franklin Institute, Benjamin Franklin Parkway at 20th, Philadelphia, Pennsylvania.

The promotion and acceleration of metallic corrosion by microorganisms, by T. Howard Rogers. Reprint from the *Journal of the Institute of Metals*, 1948, Vol. 75, Pt. 1. Released by the Institute of Metals, 4 Grosvenor Gardens, London, S. W. 1.

Studies in Japanese Pselaphidae (Coleoptera), I. Introductory materials checklist, and key to genera, by Orlando Park. (Bulletin of the Chicago Academy of Sciences, November 30, 1948.)

The neutral element base of matter and probable cause of gravitation, by Santiago Antunez de Mayolo. Lima, Peru: Universidad Nacional Mayor de San Marcos, 1948.

Solar Energy

Farrington Daniels, *University of Wisconsin*

FROM THE DAWN OF HISTORY man has realized the importance of the sun, but only in the present scientific age has he begun to appreciate the vastness of this source of energy and the extraordinarily clever mechanisms by which nature makes efficient use of it. In these times of profligate spending of the world's natural resources (*12*) and uncontrolled increase in population (*12, 18*) it is our task on this 100th anniversary of the founding of the American Association for the Advancement of Science to try to see what lies ahead. Science has pulled us out of many difficulties in the past—and has given us the means for getting ourselves into worse ones. When we have used up our coal and oil, exploited our available land with intensive farming, and trebled our population, can we then call on the sun to give us still more means to satisfy our ever increasing demands for food, fuel, and power? *The answer is yes.* But there is a long challenging road of research and development which must be followed first—and we must not get the idea that we are about to step into a new era of physical and economic abundance. We can't eat sunshine, we can't carry it where we want to use it, and, because it cannot easily be used to produce high temperatures, we find it is difficult to apply directly in our heat engines.

AMOUNT OF SOLAR ENERGY

The earth intercepts a prodigious amount of radiant heat from the sun (*13*)—about 5×10^{20} large calories or kilocalories per year, arriving at the surface of the earth. Five followed by 20 zeros is too large a figure to register with most of us, but suppose one considers the amount of energy in terms of an acre. An acre is roughly a square of land 200 feet on a side, a little less than the length of half a city block, with an area of about 40,000 square feet. In most parts of the United States the solar energy averages more than one kilocalorie per square foot per minute (*6*), or 500 kilocalories per day. Since each one of the 40,000 square feet in an acre receives 500 kilocalories each day, the whole acre receives 20,000,000 kilocalories per day. Let us see what these figures mean in terms of food, fuel, and power. In the continental United States there are now nearly 144,000,000 people and nearly 2,000,000,000 acres of land (*21*), giving an average of about 14 acres per person, and a theoretical average of 280,000,000 kilocalories of sunlight per day per person.

Each person uses about 3,000 kilocalories to maintain himself with food, and vastly more for heat and power. In 1946, 583,000,000 tons of coal (*22*) were used for, heat, light and power by 140 million people in 365 days—an average of 20 pounds person per day or 75,000 kilocalories; 1,700,000,000 barrels of oil were used for heat and power including automobiles —an average of 50,000 kilocalories per person per day; nearly 4,000,000,000,000 cubic feet of natural gas were used, an amount equivalent to 21,000 kilocalories per person per day. On the average then, each person had 3,000 kilocalories from food and 146,000 from coal, iron, and gas—a total of nearly 150,000 kilocalories per day. When this total is compared to his theoretical average of 280,000,000 kilocalories from the sun, we see that the sun supplies to the United States nearly 2,000 times as much heat energy as is now used. It must be emphasized that most of the heat energy now used comes not from the daily supply of solar energy but from the solar energy stored up in bygone ages.

UTILIZATION OF SOLAR ENERGY

Of the sun's radiation which hits the earth's atmosphere a considerable portion is reflected and scattered, so that about 1 kilocalorie per minute on the average, in the Temperate Zone, reaches a square foot of land or water. Some of this is used in the evaporating of water which, however, releases this heat again when the water vapor condenses as rain or snow. Most of the visible sunlight, constituting about half of the total radiation reaching the earth, can be used for producing carbohydrates and other organic material if it strikes growing plants on land or in the sea, and the remainder is available for raising the temperature. The tendency for the earth's temperature to rise, due to solar radiation and by decay of radioactive elements in the earth, is nicely counterbalanced by the cooling caused by infrared radiation from the earth corresponding to the earth's temperature (*2*).

How can we convert this 20,000,000 kilocalories per acre per day into useful power? If it could be used to operate a modern steam engine or hot gas engine with a normal efficiency of 25 per cent, we could obtain electrical power equivalent to 240 kilowatts per acre. But this plan is not now practical because the sun's radiation falling on the earth's surface does not create high temperatures unless it is concentrated or special precautions are taken to reduce heat losses.

"Solar Energy" was one of the addresses delivered at the Symposium on Sources of Energy, held in Washington, D. C., on September 15, during the Centennial Celebration of the AAAS.

Just as we must have a difference in level, that is, a waterfall, for a mass of water to produce hydroelectric power, so we must have a difference in temperature for heat to do work. The maximum efficiency obtainable is completely set by the difference in temperature, divided by the higher temperature. The possibilities and limitations of utilizing solar energy for engines and for house heating have been considered by Professor Hottell (*8*) of MIT. He estimates that an acre of Arizona sunshine might produce 37 kilowatts or 50 horse power and New York sunshine might produce 23 kilowatts or 30 horse power. He concludes that we do not yet have enough facts to determine the economic practicality of solar engines. It may be noted in passing that it usually takes more than one acre of sunshine on farm land to support one horse and that an average farm horse does not work more than 1,000 hours out of 8,766 hours in one year.

Even with expensive lenses or reflecting mirrors spread over a large area, it is not easy, even on cloudless days, to raise the temperature high enough to give very efficient conversion of heat into work; and when the sun is obscured with clouds, a focusing system is inoperative.

Some attempts have been made to operate vapor engines with low-boiling liquids or with water under reduced pressures. These engines are rendered somewhat more practical if they can be located near a large body of cold water to cool the condensers to a low temperature, but the small temperature difference and the low thermodynamic efficiency is a serious handicap.

Windmills are operated, of course, by differences in air pressure caused by solar energy—but, although they are very useful in certain areas, they are sporadic in operation and do not seem destined to play an important role in meeting the demand for large amounts of power.

Let us consider another approach for the direct conversion of heat into work. Thermocouples made by joining two wires of unlike metals will generate electricity when one junction is hotter than the other. We can produce electricity by placing one junction in the sunlight and one in the shade, but the voltages obtainable are of the order of a few thousandths of a volt per junction and, if we use a large number of junctions in series, we automatically increase the resistance of our wires to very large values. On a small scale, intense radiation from the sun can be converted into electricity with an efficiency of a few per cent with expensive equipment. The best commercially available thermocouple material can convert 0.8 per cent of the sunlight absorbed, under favorable conditions, into electricity. Special alloys in the laboratory give promise of a still higher conversion (*16*).

We have photochemical cells which generate electricity when one of the electrodes is exposed to the light and the other is kept in the dark. Again the voltages are very low and the resistances very high so that direct generation of thousands of kilowatts of electricity does not now appear to be practical. For house heating, high temperatures are not required and here seems to lie an opportunity for making more use of the sun. Hot water for houses is now being provided by solar radiation (*3*). Certainly all scientific principles should be followed in the use of absorbing and reflecting surfaces to obtain maximum heat from the sun in winter and minimum heat in the summer. Heat storage beds of cheap, quick, heat-exchanging materials should be more thoroughly explored as a means for equalizing temperature—storing the heat of the day to be blown through the house during cool nights and storing the cold of the night for air conditioning on hot days. An attractive approach lies in the storage of solar heat in chemical or physical changes. Miss Maria Telkes, of the Massachusetts Institute of Technology, is conducting practical research along these lines, and she has summarized the situation with reference to solar house heating (*17*). Lof (*9*) and others have studied the problem of house heating.

Although solar engines for power and mechanical devices for storing solar heat are not impossible, they do not now appear to be practical enough to be important on a large scale. We must look elsewhere for the conversion of sunlight into useful power and stored heat. Let's consider using the sunlight to bring about some cheap, efficient photochemical reaction to obtain a product which we can carry around with us and then release the stored energy when and where we please by a second chemical reaction. It would be a good idea to combine carbon dioxide and water to form carbohydrates and other organic materials, and then burn them in the oxygen of the air with the evolution of heat at high temperatures. This sounds like a good idea but there are two serious difficulties—neither carbon dioxide nor water absorb sunlight, and without absorption there can be no photochemical reaction. Even if we found a third substance which would absorb the sun's radiant energy and transfer it in some mysterious manner to the carbon dioxide and water, the energy in the units of radiation, called photons, amounts to only about 40 to 60 kilocalories per mole while the energy required to make carbohydrates from carbon dioxide and water is more than 112 kilocalories per mole. Nevertheless, nature solved this problem in a very beautiful manner with chlorophyll and started production of carbohydrates in growing plants soon after the earth cooled enough to permit the existence of organic material.

This process, in which carbon dioxide and water are transformed into carbohydrates by sunlight in the living plant, is called photosynthesis.

Nature did us another good turn by accumulating this carbohydrate material over millions of years, altering its chemical structure to give a greater percentage of combustible carbon, and storing it, so that we can have convenient fossil fuels packaged as solids, liquids, or gases—coal to be shoveled and shipped in chunks, petroleum to be pumped and carried in tanks, and natural gas to flow easily through pipes.

Again man was provided with a means for getting work done long before he had evolved far enough to invent heat engines. He could obtain mechanical power from the organic material, photosynthesized by the sun, by feeding it directly to men, horses, water buffalo, or other animals, and then persuading them to do his work for him. The conversion of chemical energy into useful work in this intricate animal process is not limited, as heat engines are limited, by the requirement of a large difference in temperature, but by other factors not yet fully understood.

TABLE 1

TYPICAL AGRICULTURAL UTILIZATION OF SUNLIGHT

Crop	Crop yield/acre/year
Corn (1946 average, U.S.)	33 bushels (0.9 ton)*
Wheat (1946 average, U.S.)	17 bushels (0.5 ton)*
Hay, tame (1946 average, U.S.)	1.5 tons
Hay, wild (1946 average, U.S.)	0.9 ton
Florida pine (total wood material)	3 tons
Wisconsin aspen (total wood material)	2 tons

* The organic material (cellulose) of leaves, stalks, etc. gives an additional .9 ton, approximately, for corn and 0.5 ton for wheat.

More recently man has tried to compete with nature in using atomic energy under controlled conditions, but the much publicized atomic energy cannot compare with the sun's energy. An atomic bomb with its equivalent of 20,000 tons of TNT has 20,000,000,000 kilocalories, which is no more than the heat of the sunlight which falls on 1½ square miles of land in a day.[1] The difference of course is that in an atomic bomb the energy is wrapped up in a small package and released instantaneously. Only a small fraction of the sun's energy can be utilized in any operation which involves high temperatures.

PRODUCTION OF FUEL AND FOOD

Of the nearly 2,000,000,000 acres of land in the United States (*13*) a little more than half is used for farming and about a third is forest, the rest being largely grazing land, desert, mountains, and city land. Much of our land, therefore, is now using the sun's radiation to grow vegetation of some kind—crops, forest, or grass—but the utilization of solar energy is often inefficient.

In Table 1 are shown average yields per acre for four crops in the United States for 1946 (*20*).

EFFICIENCY OF PHOTOSYNTHESIS

We have just seen what average yields are now obtained in the conversion of sunlight into plant material and have learned that two tons of wood material can be grown in a year on an acre of aspen in Wisconsin under good operating conditions of continuing forest growth. When this annual growth of wood material is burned, it will yield 8,500,000 kilocalories, whereas the sun's radiation falling on the acre is 7,300,000,000 kilocalories per year. This results in a return of a little less than 1/10 of 1 per cent of the sun's energy.

The case is somewhat better with corn on fertile soil. On some Iowa farms the yield of shelled hybrid corn is 100 bushels per acre and the weight of the cobs, leaves, stalks, and roots is about equal to that of the corn. If all this organic material is burned, about 20,000,000 kilocalories will be evolved, amounting to a conversion of 3/10ths of 1 per cent of the year's solar radiation. If one remembers that the growing season is less than a third of the year, it is evident that the corn actually converts about 1 per cent of the possible radiation into organic material. According to one experiment in which the light was measured and the corn and leaves and roots accurately weighed, a conversion of 1.6 per cent was obtained during the growing season (*11*), or about 0.5 per cent of the year's sunlight.

What are the factors which make for this low efficiency? As just explained, the growing season is short—only about a third of the year. The green chlorophyll of plants does a remarkable job of absorbing light all the way from ultraviolet light to red light at 6,800 A and utilizing it in photosynthesis, but even so it does not absorb more than half of the total range of the sun's radiation. Most of the other half lies in the heat rays or infrared radiation. Again, particularly in the first part of the growing season, the plants are small and much of the acre is not covered with leaves. The layers of leaves are not thick enough to absorb all the absorbable light. Obviously, it is only the light which is absorbed by the plant that can have a part in photosynthesizing new plant material.

In order to obtain the maximum production, all the conditions must be optimum. For example, if sunlight is to be the limiting factor in getting the maximum amount of plant growth, the other necessary major and minor chemical elements must all be present in adequate amounts. For, example, a given amount of sunlight will not give the maximum growth of plant material if the plants are too dry, or the weather too cool, or the ground too poor in soluble, essential minerals. Moreover, when the light intensity is increased, the efficiency of conversion is decreased.

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[1] One gram of TNT is equivalent to 1 kilocalorie: 20,000 tons of TNT = 2×10^4 tons × 2×10^3 lbs/ton × 453 grams/lb × 1 kilocalorie/gram = 1.8×10^{10} kilocalorie; 1½ sq mi = 960 acres; 960 acres × 20×10^6 kilocalories/acre = 1.9×10^{10} kilocalories/1½ sq mi.

The concentration of carbon dioxide in the air is only 0.04 of 1 per cent, and there is no simple way of increasing this concentration in open fields. All plant material gets its carbon from this 0.04 per cent in the air. This seems to be a small source of carbon for all the vegetation of the world, but in the air over each acre there is 19 tons of mobile carbon dioxide.[2]

What is the theoretical limit to which efficiency in photosynthesis can approach when all other factors involved are present in abundant quantities and sunlight becomes the limiting factor? Under optimum conditions, nearly 10 units of radiation, called photons, must be absorbed by chlorophyll in order to cause the combination of one molecule of carbon dioxide and one molecule of water to give as much carbohydrate as is equivalent to one atom of carbon. These are experimental values, obtained with green algae in water with ample carbon dioxide, perhaps 5 per cent, and plenty of chemical food material and low light intensity. As we shall see shortly, this ratio of 10 photons per molecule means that, with green light, under the most favorable conditions, only 20 per cent of the energy of the light can be stored as chemical energy.

Remembering the 1/3 factor for the growing season and the 1/2 factor for utilizable sunlight, even with the best environment of moisture, fertilizer, and temperature, we could expect to get only 1/6th of 20 per cent or 3 1/3 per cent conversion of sunlight in an agricultural crop in the United States. The 0.3 per cent conversion of the annual sunshine in a bumper corn crop is not bad in comparison with the theoretical maximum of 3.3 per cent.

This maximum ratio of about 10 photons of light absorbed per molecule in photosynthesis has been checked in different laboratories (*10*) in several different ways. The chemical change has been determined by micro-gas analysis, by electrical methods, by chemical titration for oxygen, by differential measurements in a Warburg manometer, and by optical and magnetic methods.

Perhaps the most significant and independent measurements have been made calorimetrically (*1*). A tiny glass cell is surrounded by thermocouples which measure the heat evolved when the light passes through the cell. The light absorbed by algae in the cell is measured at the back of the cell. Of the light which is absorbed by the algae growing under optimum conditions, about 80 per cent is converted directly into heat in the calorimeter, thus leaving only about 20 per cent which can possibly be stored as chemical energy in the carbohydrate and other plant material.

MECHANISM OF PHOTOSYNTHESIS

We are just beginning to understand something about the mechanism of photosynthesis. With all the millions of dollars invested in agricultural research, it is strange that so little has gone into the fundamental process of photosynthesis which underlies all of agriculture. Few studies on photosynthesis have been made by federal or state agricultural laboratories; and active programs of work in quantitative photosynthesis has been in progress at only about a dozen universities and institutions.[3] Three symposia on photosynthesis have been held—under the Chemistry Section of the American Association for the Advancement of Science.[4]

The fundamental reaction of all plant life involves the combination of carbon dioxide and water. When a carbohydrate like sugar or cellulose is burned the reaction is represented as follows:

$$\text{carbohydrate} + \text{oxygen} = \text{carbon dioxide} + \text{water} + 112 \text{ kilocalories}$$

$$1/n(CH_2O)_n + O_2 = CO_2 + H_2O + 112 \text{ kilocalories}$$

If this reaction is reversed at least 112 kilocalories must be absorbed and, unless the processes are 100 per cent efficient in all their steps, the amount of energy required may be much more. The reaction occurring in the plant is written as follows:

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[2] (0.0004 × 15 lbs/sq inch × 43,560 sq ft/acre × 144 sq inch/sq ft) ÷ 2,000 lbs/ton = 19 tons/acre.

[3] Including among others: University of California (isotopic tracers and mechanisms); Carnegie Institution of Washington at Stanford University (plant pigments and photochemical efficiency); University of Chicago (mechanisms, fluorescence, isotopic tracers, and photochemical efficiency): Harvard University (efficiency of forest growth); Hopkins Marine Station (enzyme reactions, photochemical efficiency, and various algae); University of Illinois (general photosynthesis and photochemical efficiency); Iowa State College (absorption of light by leaves); Kettering Foundation at Antioch College (chlorophyll and related plant pigments); University of Minnesota (chlorophyll and related pigments, photochemical electrical cells, isotopic tracers); Smithsonian Institution (influence of color and intensity of light on plant growth); University of Texas (protein production in algae); University of Wisconsin (photochemical efficiency and mechanisms); Massachusetts Institute of Technology (direct utilization of solar energy).

[4] Symposia, AAAS, Section C, Columbus, Ohio, 1939; Gibson Island, Maryland, 1941; Chicago, Illinois, 1947.

carbon dioxide + water + chlorophyll + >
112 kcal = carbohydrate + oxygen
$CO_2 + H_2O + (\text{chlorophyll}) + >$
$112\ \text{kcal of sunlight} = 1/n(CH_2O)_n + O_2$

Green light corresponds to 55 kilocalories per mole, and two photons must be brought together to provide this minimum of 112 kilocalories per mole. Red light of 40 kilocalories per mole requires nearly 3 photons per molecule to meet the *minimum* energy requirement of 112 kilocalories. In actual photosynthesis, we have found that about 10 photons are required for one molecule. Now this use by nature of several low-energy photons to do a high-energy job is unique. We haven't done it yet with inorganic materials, and only in the last few years are we beginning to understand how nature does it.

Several laboratory findings have contributed to this understanding. In the first place, earlier theories of photosynthesis were handicapped by the belief that photosynthesis is very efficient, about 60 per cent (*19*) instead of the 20 per cent now accepted. In the second place, important advances have been made recently in understanding enzyme chemistry and the utilization of energy in yeast, bacteria, and other biological systems.

Many miscellaneous facts are known concerning photosynthesis which are helpful in developing a satisfactory theory. Only a few can be mentioned here.

Green chlorophyll absorbs the light and acts as the intermediary for supplying the energy from the sun which is required in the complex series of reactions by means of which the carbon dioxide and water combine to give carbohydrate. Chlorophyll has intense absorption bands in the red and blue, but in thick layers it absorbs light throughout most all of the visible spectrum. The maximum efficiency of photosynthesis is nearly the same for red, blue, or green light. Respiration, which is the reverse of photosynthesis, goes on continuously in plants. The plants, like animals, consume oxygen and give off carbon dioxide. The addition of glucose and other soluble organic foods increases the rate of respiration of plants, but it does not affect the rate of photosynthesis.

The ratio of oxygen evolved to carbon dioxide absorbed is often about 1 to 1, but this can be true only for the production of cellulose and other carbohydrates. The ratio cannot be unity in those plants and algae which produce considerable amounts of proteins and fats. An exact determination of the oxygen-carbon dioxide ratio is helpful in giving information concerning the composition of the organic materials produced in photosynthesis.

The photo reactions pile up fresh organic material, which is used by the plant in a series of reactions which go on in the dark. Valuable information concerning the dark thermal reactions and the photo reactions has been obtained by exposing plants to intermittent light with dark periods ranging down to fractions of seconds (*6*). Again the dark and light reactions can be partially distinguished by changing the temperature because the dark reactions are accelerated by an increase in temperature whereas the photo reactions are nearly independent of temperature.

One of the newest and most promising attacks on the mechanism of photosynthesis lies in the use of isotopic tracers. When plants are grown in carbon dioxide which contains radioactive carbon, the first chemicals produced in photosynthesis are identifiable by means of their radioactivity. Active and significant work is now going on with radioactive carbon (*14*). Experiments with water containing the heavy isotope of oxygen revealed the significant fact that the oxygen released in photosynthesis comes from the water (*15*) and that the oxygen of the carbon dioxide remains in the plant materials.

With the help of these laboratory findings and many others, a satisfactory hypothesis is beginning to unfold. Following the primary photo reactions are many thermal reactions which are aided by enzymes. The over-all energy requirement of more than 112 kilocalories is too great to be met by one unit of light, one photon, and the reaction must be carried out in a series of steps, one photon being used for each step.

Apparently the carbon dioxide adds to an organic substance of low molecular weight and forms a carboxyl or acid group. This new substance is subsequently reduced by hydrogen made available through the photochemical dehydrogenation of water. Perhaps four steps are involved, each requiring a photon; and then four more reactions with four more photons are required to restore the hydrogen atoms to these intermediate compounds, ready to be used again. This gives a total of eight photons through a series of eight intermediate steps, which carry the hydrogen from the water to the carbon dioxide, thus releasing oxygen and forming the carbohydrate material, CH_2O. If this picture, proposed by James Franck, of the University of Chicago, is correct we have a plausible explanation for the experimental fact that about ten photons are required.

THE NEXT HUNDRED YEARS

When it comes to predictions, the news reporters probably take delight in pushing the scientist out on a limb—just to see the splash. However, on this 100th anniversary there may be a legitimate demand for a little speculation.

The days of easy geographical quest for more food, fuel, and power are over, and our frontiers now lie in science and engineering. We can no longer afford to waste valuable fuel in fireplaces and stoves that send most of the heat up the chimney nor in low temperature engines that are thermodynamically inefficient. An *average* steam locomotive converts not much more than 5 per cent of the heat of the burning coal into useful work. In the future, it will be necessary to increase the efficiency of our utilization of sunlight, to conserve all our resources, and to control the birth rate of the world's population. We have seen that we are now using only a small fraction of the solar energy which is available and that, theoretically, we should be able to appropriate a much greater part of it. We have seen that present prospects are not bright for the conversion of solar energy into electrical power through heat engines, thermocouples, or photochemical cells, but revolutionary discoveries might well lead to more optimistic possibilities.

Our discussion has emphasized the situation in the United States because it was difficult to obtain statistical information regarding the utilization of sunlight over the whole world. We are emphasizing on this anniversary occasion, however, that science is worldwide. Let us add, then, that the area of the United States is but a small fraction of the earth's surface and that any improved conditions must be thought of in terms of world application. In the tropics there is a greater opportunity for utilizing solar energy because the energy is greater than the 1 kilocalorie per square foot per minute in the United States and the growing season is not confined to a third of a year. The soil and certain agricultural conditions are somewhat less favorable however. Also to be considered are the great areas covered by oceans where photosynthesis goes on in diatoms and other sea plants. Perhaps more organic material is being produced now in the sea than on the land.

It is possible now to grow plants without soil, using barren sand or tanks of water containing the necessary chemical elements. This science of hydroponics has been developed to a point where such operations are practical, even if not economically competitive except in special areas. Probably the utilization of sunlight can be made more efficient in this way and the operation can be applied where there is no soil suitable for ordinary farming.

Let's consider one step further. What chance is there that we can combine carbon dioxide and water to give organic material without the agency of a living plant? We can perhaps find some combination of colored dyes and enzymes which will do what nature now does with green plants? This has not been done yet, but there is no obvious theoretical reason why it cannot be done some time in the future. As a matter of fact, if someone had asked me to guess ten years ago which would come first, atomic energy or photosynthesis without the living plant, I would have guessed the latter. But now we have atomic energy —or at least we *can* have it. It resulted from the unexpected discovery of fission, an investment of five years of intensive cooperative research by many hundreds of scientists and engineers, and the expenditure of $2,000,000,000. The corresponding investment in photosynthesis has been negligible. A really large program of research on the greater utilization of solar energy might produce significant developments. Solar energy is our most promising resource in the long-range view.

There is no assurance that photosynthesis outside the living plant will be any better or cheaper than present photosynthesis in plants. Very likely agricultural research similar to that already carried out will provide our best means for increasing the efficiency of our utilization of solar energy where the soil is good.

Even if we could produce food without the growing plant, our present farms would not fear competition from the cheap land and bright sunshine of Arizona. Any type of artificial photosynthesis would probably require shallow tanks, possibly of concrete covered with glass, and the investment would be too great to consider in economic competition. Moreover, any possible development of this kind would come slowly enough to give ample time for economic and social readjustment. Scientists of the future should consider photosynthesizing organic or inorganic products of an energy content lower than cellulose and carbohydrates. It might be easier. Possibly they might tackle the problem of muscular action produced by chemical reactions involving photosynthetic material, thus attempting to follow the pattern of animal work. There are serious limitations in efficient conversions of food energy into animal work, but they are perhaps less well defined than the second law of thermodynamics, which limits the efficiency of heat engines.

Looking less far into the future, what important changes are apt to come? We shall have to find ways to increase the food and fuel supply of land areas which are not now suitable for growing standard food crops. The wheat and meat of the limited, rich, farming lands cannot be used indefinitely to feed the world. Trees and quick-growing bushes and grass can be grown on poorer soil, and it is now perfectly practical to eat wood products. In fact, thousands of tons of wood yeast were used for human food in Germany during the war. Sixty-five to 70 per cent of most woods can be converted into sugars by heating with dilute sulfuric acid to 120°–150° C under special conditions (7) developed at the U. S. Forest Products Laboratory. This material can then be used for growing yeast and producing alcohol which can be used for liquid fuel. The wood yeast is as rich in proteins as beef steak and can be used for food.

These cellulose yeasts are cheap, and they possess splendid nutritive value. With intensive research on improving the flavor, this source of protein should be of great help in solving a food shortage, particularly in the tropics, where the large-scale production of meat is difficult. Nitrogen compounds must be supplied to these growing yeasts in order to produce proteins. Possibly this fixed nitrogen can be supplied directly from the nitrogen of the air by a new process in which the air is heated to a high temperature. Present methods of utilizing sunlight to increase proteins include the feeding of plant material to chickens, hogs, and cattle. Fish farms should probably be expanded in certain areas. Intensive research should be directed toward utilizing diatoms and other sea plants as food. They can be hydrolyzed to produce sugars that can be used directly or as a means of producing edible proteins from yeast. The supply of aquatic vegetation in the oceans is enormous; and in fresh-water lakes and streams the algae and weeds should be harvested anyway because they are often a nuisance.

The utilization of farm products for local fuel is another development that can be around the corner, but the present cost of harvesting bulky, low-value products is high. If farm prices fall it may be more difficult for the farmer to pay cash for gasoline and oil for the tractors that have replaced the hay-eating horses. Wood and corn stalks and other cellulose material have been converted into alcohol—60 gallons to the ton. New developments of the Fischer-Tropsch synthesis of hydrocarbons assure us that it will be possible to convert waste organic material into carbon monoxide and hydrogen, which, with the help of iron and cobalt catalysts, can be converted into hydrocarbons and satisfactory motor fuels. Research should be directed toward developing medium-sized units for farm areas. It must be determined under what conditions part of the farm products should be used for fuel and returned to the land to improve the soil.

Some of these developments that I have suggested will come slowly, not because of technical difficulties, but because of economic circumstances. For the present, nature has supplied man with such abundant sources of fuel and food that he will not be pushed to these new things for some time unless there continues to be unequal distribution among the nations of the world due to war and political short-sightedness. It is comforting, however, to know that we can get more from the sun when we need it and that, theoretically at least, the scramble for oil and coal could be eased.

Science must go forward, regardless of immediate practical applications, accumulating a reserve stock of knowledge that can be used in any emergency. We must learn how to use our rich heritage of sunlight more efficiently so that we can be prepared against such catastrophes as war, overpopulation, exhaustion of oil and coal, and the return of the glaciers (*4*). The scientists, too, must cooperate with the social scientists and statesmen so that adequate preparations can be made for any social, economic, and political readjustments that may follow the scientific developments.

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Uranium Deposits in the USSR

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CONTRARY TO POPULAR IMPRESSIONS, a fair amount of authentic information has been published on the uranium resources of the Soviet Union. Because of widespread interest in this subject, I believe it worth while to summarize the pertinent facts.

According to Vernadskii (*26*, especially pp. 56–70), Russian research on radioactive minerals began in 1900–1903 with the work of I. A. Antipov in the Fergana Valley (40° to 41° N, 70° to 73° E) of Russian Central Asia. Beginning in 1909 the Imperial Academy of Sciences initiated more ambitious investigations. All previously gathered information was sifted carefully, so that field work in 1911–1913 could be concentrated on the most promising localities: the Fergana Valley, Siberia, the Caucasus, Transcaucasus, and Urals. By 1914, indications from the Caucasus and Transcaucasus had become negative. In the Urals no indication of deposits of sufficient size for commercial exploitation could be found. Two areas appeared promising. One was Tyuya Muyun (40° 21′ N, 72° 0′ E) in the Fergana Valley, with deposits of *tyuyamunite*, $Ca(UO_2)_2 \cdot V_2O_8 \cdot 6\,H_2O$, closely comparable to the carnotite of the American southwest.[1] The other was the northwest slopes of the Khamar-Daban Range (51° to 52° N, 103° to 106° E), especially near Slyudyanka (51° 40′ N, 103° 35′ E) and along the Trans-Siberian railroad between Baikal and Kultuk immediately across Lake Baikal, characterized by sites rich in *mendelyeevite*, with the probable composition, $2\,CaO \cdot 2(Ti, U)O_2 \cdot (Nb, Ta)_2O_5$, strikingly similar to betafite and allied niobium-tantalum-uranium minerals of Madagascar.[2]

In 1914, a three-year program of research was authorized for the Academy of Sciences. The largest sums were to be devoted to expeditions in the Baikal area and the Fergana Valley, with lesser amounts going for investigations of the placer monazite deposits of the Transbaikal and for various minor projects (*26*, pp. 71–80; *10*, pp. 15–16). While World War I prevented full accomplishment of the program of the Academy of Sciences, enough was done to establish that only the Fergana Valley and the Baikal area had possibilities of commercial development (*10*, pp. 15–16). By 1918, the new Soviet government began pressing for the resumption of laboratory and field investigations of radioactive minerals; on January 1, 1922, scattered radiological facilities in the USSR were combined in the Governmental Radium Institute of the Academy of Sciences, headed by V. I. Vernadskii (*10*, pp. 19–35).

This new Institute concentrated its efforts on the site of Tyuya Muyun. An important reason for this decision was the fact that small-scale commercial operations had been begun there in 1908. Between 1908 and 1913 the Fergana Company had mined 2,088,000 pounds of ore, 1,512,000 pounds of which had been sent to its plant in Leningrad for refining. According to Company records, the ore contained, on the average, 2.36% V, 0.97% U_3O_8, and 3.73% Cu (*10*, p. 19). Scientific study of Tyuya Muyun and the surrounding area, which had been conducted sporadically since 1914, was pressed throughout the decade 1924–1934. Detailed investigations and construction of exploratory and operating shafts permitted analyses of the site by Fersman (*4*) in 1928, Kirikov (*12*) in 1929, Pavlenko (*19*) in 1933, and Butov and Zaitsev (*2*) in 1934.

The Tyuya Muyun deposit is a vein field in highly metamorphosed Paleozoic limestone, closely—but probably not genetically—associated with extensive karst channels and caves. The vein field consists of at least five (1933) barite ore veins bearing uranium, vanadium, and copper minerals and of over 30 pure barite veins. The productive veins are found near the center of the deposit, being located along a line conforming with the NE 70° strike. The barite veins extend up to 1,500 meters from the center; the maximum depth of the main vein may reach 500 meters (*12*, especially pp. 63–5, *19*).

The ore bodies within the productive veins vary in thickness from 1.5 meters to a few centimeters, and correspondingly in length. Run-of-the-mine ore averages 1.5% U_3O_8, with a range of 0.6 to 4.0%, the higher values being found in the lower horizons. However, the uranium oxide content of the amorphous, brown, cupro-uranium carbonate lenses associated with the karst stalagmitic core runs from 26.12 to 50.25%. Also noteworthy are the uranium-free radiobarites—$(Ba, Ra)SO_4$—and radiocarbonates—$RaCO_3$—established in relatively high concentrations at both lower and upper horizons of the deposit (*4*,

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[1] Fersman (*4*, p. 47) and Kirikov (*12*, p. 42) give an alternative analysis, $V_2O_5 \cdot 2\,UO_3 \cdot CaO \cdot nH_2O$. The replacement of the Ca^{++} by 2 K^{+} gives the formula of carnotite, cf. Betekhtin (*1*, p. 284).

[2] This affinity was recognized by V. I. Vernadskii in 1914, cf. *18*, p. 236; see also *6*, p. 270, and for betafites, *13*, I, 365–392.

12). The irregularity of the Tyuya Muyun deposit has made impossible the estimation of reserves; the mine produced 534 metric tons of hand-sorted ore in 1925–26 (*7*, pp. 571–573). By 1936, according to Nikitin (*18*), the quantity of radium extracted from the Tyuya Muyun ores and from radioactive waters near Ukhta (approximately 63° 35′ N, 53° 40′ E) was enough to meet the needs of the Soviet Union.

The origin of the Tyuya Muyun deposit is highly controversial. Careful examination of the literature has led the writer to believe that (1) the original source of the uranium has not been satisfactorily established; (2) that deep, relatively low-temperature, hydrothermal processes, possibly connected with the Variscean revolution of the Upper Paleozoic, appear to have been the primary agents of deposition; (3) that subsequent orogenic movements (Alpine?) faulted the deposit; (4) that the post-Eocene karst redistributed the deposit, partly destroying veins, partly reconcentrating ores. Interesting parallels may be found with the Ukhta radium-bearing wells, particularly in regard to the high concentrations of radium, mesothorium, and barium (*3*, *5*).[3]

Explorations in other parts of the Fergana Valley have also been undertaken. In 1928, numerous indications of intense radioactivity were discovered in the western part of the Valley, but no uranium deposits (*22*, *23*). In 1923, however, V. I. Popov published an account of the discovery of a uranium deposit at Uigar-sai or Atbash (41° 02′ N, 71° 12′ E) on the northern side of the Fergana Valley. Geologically, the site was said to be closely similar to carnotite deposits in Colorado and Utah. It is characterized by young, stream-deposited lenses of urano-vanadium ore, some of considerable size and richness. "In terms of its high percentage of content, dimensions of individual ore bodies, and probable reserves, the urano-vanadium deposit discovered at Uigar-sai does not yield to many carnotite sites in the U. S. A. The deposit is found under very favorable economic conditions, being situated at an automobile road; it is to undergo survey in 1939" (*21*).

Volfson's comprehensive survey of metallogenesis in the western Tian Shan range (*27*) also gives brief details of other newly discovered deposits at Taboshar (40° 37′ N, 69° 39′ E) and Maili su (41° 18′ N, 72° 27′ E). In the first of these, which has also been described by Mashkovtsev (*16*), uranium pitch (pitchblende?) is associated with bismuth glitter, wolframite, arsenopyrites, and sulfide polymetallic (lead, zinc) deposits. According to Mashkovtsev's preliminary report of 1928, the indicated uranium content of the ore is only of the order of 0.12–0.2%, which probably deprives it of economic significance. In the second site, infiltrations of urano-vanadium compounds are associated with tertiary limestones. Neither site was being commercially exploited in 1940 (*27*).

In evaluating the significance of the Central Asiatic sites, it should be noted that, according to the Soviet prospecting plan for 1940, search for uranium and radium was to be concentrated in that area (*8*).

Two other recent finds of uranium-vanadium ores in Central Asia may be mentioned. In 1937, Gotman (*9*) published an account of the deposit at Agalyk (39° 32′ N, 66° 52′ E); petrographic analysis of surface finds here established that tyuyamunite was the most frequently occurring ore. The geology of the site remained unclear; some evidence of primary deposition existed, but secondary hydrothermal deposition could not be excluded. Sampling at groundwater depths (50–60 m) would therefore be necessary to establish the potentialities of the site; no data are available as to whether such sampling has been undertaken. In 1940–41, the presence of uranium was established by Tyurin (*24*) in a vanadium site in the northwestern tip of the Karatau Range (44° 30′ N, 67° 30′ E). It represents a sedimentary deposit with subsequent metamorphism which has created a reiterated interbedding of thin bands of vanadium ores (with uranium-mineral accumulations) with flint bands. The total amount of uranium in the ore body (which extends for 25–30 km, with a thickness of 10–14 m) is great; but the improbability of finding large pockets of uranium and the difficulty of separating the disseminated uranium from vanadium on a large scale are serious obstacles. According to Tyurin, the preliminary surveys of 1942 should be followed by more extensive explorations of the area.

In the area of the Khamar-Daban Range, serious investigations have been undertaken only at Slyudyanka, which is significant as a phlogopite mica deposit. Luchitskii and his collaborators (*15*, pp. 74–95, 146–7, 236) verified the presence of mendelyeevite and established the existence of two phases, crystalline and amorphous, with differing compositions and physical properties. For instance, two analyses of the crystalline phase yielded 36.75% Ta_2O_5 and no Nb_2O_5; 14 analyses of the amorphous phase, 39.46% Nb_2O_5 and 3.82% Ta_2O_5. Total uranium-oxide content in all samples ranged from 19.70 to 28.90%.

From an economic standpoint the results at Slyudyanka seem to be negative for mendelyeevite was found only in the pegmatite veins of two parts of the deposit, in which it appears generally to play a subordinate role. The productive sector (Zayavka No. 5) consists of a large mass of Pre-Cambrian crystalline limestones, penetrated by a 200-meter-thick band of biotite and biotite-granitic gneisses, which in turn are interlaced—in places, virtually engulfed—by the thick pattern of pegmatite veins in which mendelyeevite has been found. The bulk of the phlogopite veins of the sector are associated with the pegmatite-gneiss zone of contact.

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[3] This interpretation is supported by L. A. Osipov's (*Sovietskaya Geologiya*, 1941, No. 3, 36–48) association of the Fergana uranium deposits as a group with Paleozoic oil-bearing marine formations.

Despite the seemingly negative picture at Slyudyanka, the widespread development of formations closely resembling the productive sector of this deposit from the Sayan Range (approx. 50° N, 100° E) northeastward to the Aldan gold fields (approx. 58° N, 125° E) cannot be ignored (*6*, pp. 382–3, 467–9, 552–560). A genetic association may exist between niobium-tantalum-uranium ores and phlogopite mica; their immediate proximity at Slyudyanka and their relative proximity in Central Madagascar (Volorondrongo and Ambatofotsy) raise unanswered questions.[4] Thus the discovery of three major phlogopite mica deposits in the Aldan gold field area—Emeldzhik (approx. 58° 22′ N, 126° 40′ E), Kuranakh (58° 46′ N, 125° 35′ E), and Chuga or Ust Nelyuka (58° 06′ N, 123° 0′ E)—heightens the probability of corresponding uranium finds to an unknown degree (*20*).

Finally, it should be mentioned that Fersman (*6*, pp. 480–484, 579) attached great importance to further study of the Ukrainian magnetito-ortite pegmatites, particularly in the areas of Novograd Volynskii (50° 30′ N, 27° 40′ E) and Berdyansk-Mariupol' (46° 40′ N, 36° 50′ E to 47° N, 37° 30′ E). He emphasized the likelihood of large, unexpected discoveries of Nb, Ta, U, Ti, and other minerals in these areas.

In brief, Soviet discoveries of uranium in Central Asia within the last decade, while in no sense approaching the great significance of the African and Canadian deposits, appear to provide a possible basis for the development of atomic power in that area. It must be stressed that all of the Central Asiatic deposits are found within a radius of 250 miles from the important hydroelectric plants of the Tashkent area, which produced 882,000,000 kilowatt-hours of energy in 1943 (*28*, p. 53). Labor, transportation, and climatic conditions are also favorable here.

Possibilities for the discovery of significant uranium deposits associated with pegmatites in the region between Lake Baikal and the Aldan gold fields, and in the Ukraine, also exist.

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[4] See *13*, I, pp. 365–392, 474–476; II, pp. 122–135, 145–147.

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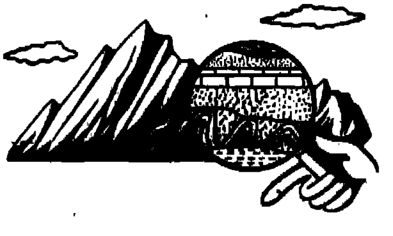

TECHNICAL PAPERS

Pentavalent Manganese[1]

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In fused alkaline melts, the lower oxides of manganese react with oxygen until an oxygen-to-manganese ratio of about 2.5 is established (*5*). For aqueous media, reliable evidence pointing to the existence of pentavalent manganese has only recently been reported (*4*). The present paper will show that such a valence state can be detected polarographically in strongly alkaline solutions.

A solution containing 1.00×10^{-3} M potassium permanganate and 0.10 M sodium hydroxide was deaerated with nitrogen and then polarographed, using a stationary platinum electrode (*6*) and an outside saturated calomel electrode (S.C.E.). The resulting curve is shown in Fig. 1.

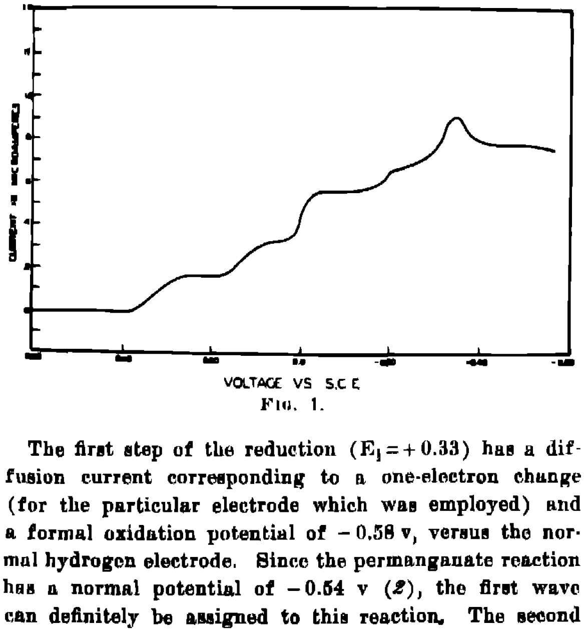

FIG. 1.

The first step of the reduction ($E_{1/2} = +0.33$) has a diffusion current corresponding to a one-electron change (for the particular electrode which was employed) and a formal oxidation potential of −0.58 v, versus the normal hydrogen electrode. Since the permanganate reaction has a normal potential of −0.54 v (*2*), the first wave can definitely be assigned to this reaction. The second ($E_{1/2} = +0.13$ v) and third steps ($E_{1/2} = +0.01$ v) also have diffusion currents corresponding to one-electron changes. Hence the reactions taking place must be $Mn^{VI} \rightarrow {}^{V}$ and $Mn^{V} \rightarrow {}^{IV}$. The fourth (and last) step beginning close to −0.2 v must be due to the reduction of Mn^{IV}. The irregularity of the step can easily be explained by the fact that the electrode is covered with a visible layer of precipitated manganese dioxide.

There is indirect evidence that the lifetime of pentavalent manganese in 0.1 M hydroxide is not more than a few minutes. The polarographic half-wave potentials and and diffusion currents appeared to be independent of the rate at which the motor-driven slide-wire changed the voltage. On the other hand, a current-voltage curve obtained by a manual method (*1*) resulted in a single broad wave. It was not surprising, therefore, that an attempt to produce pentavalent manganese by electrolysis of manganate at a suitable potential (*3*) produced a large amount of manganese dioxide. The solution had a bluish color (similar to chromous sulfate) which agrees with the work of Lux (*4*).

Preliminary studies have also been made in other concentrations of sodium hydroxide. In a 1.0 M solution, the polarogram is very similar to the one described for a 0.10 M solution; but in a 0.010 M solution, the manganate is reduced directly to manganese dioxide in a single two-electron step. A more complete study of changes in half-wave potentials with the concentration of hydroxide will be necessary before the reactions of the Mn^{V} ion can be described accurately. The results of such a study will help in predicting the behavior of technetium ions.

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Note on the Genetics of Hypercholesterolemia

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An important aspect of the expanding interest in human genetics is the detection of carriers of hereditary diseases, both in the sense of normal heterozygotes of recessive defects, as in some forms of epilepsy (*4*), and in the sense of those individuals who exhibit some predisposing condition without showing the characteristic symptoms of the disease, e.g. hyperuricemia in gout (*7*). It is elementary in all cases to determine on the basis of numerical tests the mode of inheritance, the gene frequency, penetrates, and so on. Boas, *et al.* (*1*) have recently published data on hypercholesterolemia, a disturbance of cholesterol metabolism which "may be the common denominator in most patients who have coronary artery disease." At Boas' suggestion and with his kind permission, the following analysis of their data was undertaken. These authors studied the families of patients chosen because they had proved coronary artery disease, the symptoms of which began before the age of 50. Fifty families yielded 37 families which could be used for a numerical test of the mode of inheritance, because they included more than one child in each family and at least one sibling per family was affected with hypercholesterolemia. Study of these 37 families revealed 11 families of 2 children, with 14 affected; 10 families of 3 children, with 22 affected; 10 families of 4 children, with 19 affected; 2 families of 5 children, with 6 affected; and 4 families of 6 children, with 6 affected; giving a total of 67 affected out of 126 children. When the number expected to be affected for these 37 families is calculated on the basis of a 1:1 ratio, using the corrective factors for small family size given by Hogben (*3*), for hereditary characters with complete penetrance, the result is 70.5 expected affected, with a standard deviation of 4.8.

This is clearly an excellent fit to a 1:1 Mendelian ratio, which is obtained in the case of a dominant trait when one parent is heterozygous for a dominant defective gene and the other parent is homozygous for the recessive normal allele, or which is obtained in the case of a recessive trait when one parent is homozygous for the recessive defective allele and the other is heterozygous normal. Since the data do not include the parents, a decision can be reached only tentatively as to which one of these two possibilities is a priori more probable. Data somewhat similar to those of Boas, *et al.* have been obtained and analyzed by us for the inheritance of Heberden's nodes (*6*) and hyperuricemia (*8*), in comparison with similar cases in the literature which were shown more conclusively to be due to autosomal dominance. We are thus led to the conclusion that hypercholesterolemia is an autosomal dominant trait with complete or nearly complete penetrance. As in research on many other hereditary conditions, the gene frequency, linkage relations with other genes, and confirmation of its mode of inheritance as a dominant with complete penetrance require further investigation.

Boas, *et al.* arbitrarily selected a concentration of 300 mg/100 ml as indicative of hypercholesterolemia, purposely choosing a high level to eliminate the influence of minor elevations. This happy choice has been entirely justified by the data of Peters and Man (*5*), who, in a study of 174 determinations in normal individuals, found an average serum cholesterol of 194.1 mg ± 35.6 mg/100 ml. Three times this standard deviation above the mean gives a limit of normality of 300.9 mg/100 ml. Such a figure, that is, would allow only 1 or 2 persons in 1,000 to be above 300 mg and still be classified as normal in cholesterol concentration in the blood serum.

Certain people with hypercholesterolemia may be considered to exhibit a genetic trait characterized by this chemical abnormality. It is not at all certain that the genetic form of this abnormality can be identified by one chemical determination without regard to age, sex, diet, or other conditions of metabolism which may elevate the level temporarily—any more than one blood sugar determination identifies unqualifiedly a diabetic, or one uric acid determination identifies a gouty individual. Further investigation may reveal hypercholesterolemia as an inborn error of metabolism (*2*) similar to gout, albinism, cystinuria, or pentosuria, which are definitely dependent upon genetic factors. Constitutional hypercholesterolemia may offer an organic explanation for some cases of familial angina pectoris and coronary artery disease, as well as familial xanthelasma and xanthomatosis.

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The Flowering and Seed-Setting of Sweet Potatoes in Puerto Rico

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The work of Hartman (*3*) reporting complete failure of flower formation in Jersey-type sweet potatoes and the more recent work of Mikell, Miller, and Edmond (*4*) have prompted us to report certain observations on the flowering of sweet potatoes in Puerto Rico.

Thirteen of 16 varieties grown in field plots at the Federal Experiment Station flowered during the fall and winter of 1947–48. These were grown from sprouts, set in the field in July. Plants were trained up on 6′ chicken-wire trellises and were kept thinned by constant pruning, following the methods of Miller (*5*). It was not found necessary to girdle the plants.

Among the varieties which flowered was one of the difficult-to-flower Jersey types, Orange Little Stem. Two out of three plants of this variety included in the trials began to flower early in December and continued through the middle of January.[2] These flowers opened at the same hour and were very similar in appearance to the flowers of other varieties. Microscopic examination of the pollen showed it, also, to be similar to that of the other varieties, with considerable variation in size and many shrunken grains. Anthers and stigmas were normal and functional, except in one or two flowers, where the anthers failed to dehisce and appeared to be sterile. In all, a total of about 50 blossoms were produced, generally one or two per day, and these on particular branches. Three plants of another Jersey variety, Maryland Golden, grown similarly failed to flower.

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[1] Administered by the Office of Experiment Stations, Agricultural Research Administration, U. S. Department of Agriculture.

[2] It may be reported that this variety again started flowering in August 1948.

One hundred fifty-three crosses were made, using Orange Little Stem as the pollen parent and various of the moist-flesh varieties as female parents. Of these, only 6, or 3.9% (involving B-5928, UPR-3, Don Juan, and Mameya), were successful and set seed. This is a low percentage of set but compares favorably with 492 crosses made at the same time among moist-flesh varieties, of which only 17, or 3.5%, were successful. Seeds also were obtained from several open-pollinated Orange Little Stem flowers, thus proving this variety to be both male- and female-fertile. The open-pollinated and hybrid seeds were sent to Dr. C. E. Steinbauer, at Beltsville, for germination, distribution, and testing under a cooperative sweet potato-breeding agreement.

It is of interest that W. K. Bailey, working at this station more than 10 years ago, also reported flowering in Jersey varieties (*1*, *2*). He brought Big Stem Jersey, Vineland Bush, and Yellow Jersey into flower and succeeded in crossing the first two of these with moist-flesh varieties. Moreover, at least some of these crosses produced offspring. This early work of Bailey and the production of flowers by Orange Little Stem here at Mayaguez this past season indicate that the Jersey varieties will flower and probably are not fundamentally very different from the moist-flesh varieties, with regard to flowering, if grown under the proper environmental conditions.

The conditions under which the Jersey varieties have flowered here are: (1) an average annual rainfall of 80″ which falls off from a high of 11″ in August to 2.5″ in December; (2) a mild temperature, with average maxima and minima for August of 90° and 68° F, respectively, and for January of 86° and 62° F, respectively; (3) a day length which varies from 13.2 hrs in June to 11.0 hrs in December, with a yearly average of about 8 hrs of sunshine per day. Under these conditions, sweet potatoes behave as perennials and grow throughout the year.

Most moist-flesh varieties flower and seed profusely in Puerto Rico. This past season, plants of B-5988 and Mameya frequently produced 50–100 new blossoms each day and were literally covered with seed capsules. It is also of interest that some of these varieties appear to lose their seasonal flowering response in Puerto Rico. The varieties B-5928, UPR-3, and Mameya, which began flowering in November, 1947, did not return to a vegetative state at the end of the usual flowering period, but continued to flower during the spring and summer months. This flowering was not as profuse as during the fall and winter, but some buds and flowers were in evidence continually.

Other Jersey varieties, including Yellow Jersey, Red Jersey, Big Stem Jersey, and Vineland Bush, and the new wilt-resistant introductions, 153655, 153907, and 153909, have been included in the breeding project for the coming season. This station will cooperate with the Division of Vegetable Crops and Diseases of the Bureau of Plant Industry, Soils, and Agricultural Engineering, at Beltsville, and the sweet potato breeders of the southern states in an attempt to combine the desirable root characteristics of the Jersey varieties with the vigor, high carotene content, and fusarium wilt resistance of some of the moist-flesh varieties, through hybridization.

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Influence of Texture of Food on Its Acceptance by Rats

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It is known that rats often eat only the germ part of whole kernels of corn and leave the starchy part when sufficient corn or other food is available. The gnawing out of the germ part of corn by rats usually seems to be so precise that it has been regarded as a reliable method of determining the proportion of germ in kernels of corn and also as evidence of a high "nutritional I. Q." in rats. Some rats, nevertheless, eat the white starchy part of kernels of corn as well as the germ part but still leave the flintlike yellow part of the kernels and separated skin, which obviously has a considerable "edge resistance." It therefore appeared possible that the rats ate the germ part or germ and white starchy part of corn because these parts are of softer texture than the yellow part and skin.

To test this possibility further, 12 rats on an otherwise adequate diet and in separate cages were provided on alternate days with a supplement of dry kernels of corn and one with kernels that had been soaked in water at room temperature from 24 to 48 hrs. In practically all instances the rats ate all but the skin of the soaked or softened kernels of corn, while only the germ part or germ and white starchy part of the dry or hard kernels was eaten. It seems doubtful that a diffusion of tasty substances throughout the kernels of the corn, as a result of soaking in tap water, explains the difference in the parts consumed. It is more likely that soaked corn is less tasty than dry corn, but soaking evidently makes kernels of corn more completely edible.

The influence of the texture of food on its acceptance by rats was also noted by us in previously reported studies. Thus, in a study on rats fed vegetarian self-selection diets (*1*), it was found that no dry green peas or dry soybeans were eaten, but, when they were provided in the soaked or softened state, substantial amounts of peas (excepting the skin) and some soybeans were eaten. In a study of the effect of the addition of various types of bulk-formers to the diet of rats (*2*), it was also found that the food intake was influenced considerably by the texture of the added bulk-former. Thus, the growth of young rats, particularly females, was retarded much more by the addition of 10% ground cellophane (40 mesh) to the diet than by the addition of 10% cellulose flour (Cellu Flour). The acceptance of food by rats, like the acceptance of food by man, is therefore influenced more or less by the texture of the food.

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The Influence of Brief Periods of Strenuous Exercise on the Blood Platelet Count

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Reports in the literature on the effect of exercise on the blood platelet count have been conflicting. Behrens (*1*) found that rowing over a course 6 km long or running a distance of 200–400 m always caused an increase of 18–20% in the platelet count of trained and untrained men. Isaacs and Gordon (*3*) estimated that the number of platelets was increased 2–3 times after a race lasting 2.5–3 hrs over a 26-mile course. Biggs, MacFarlane, and Pilling (*2*) observed platelet increases of approximately 20–40% in subjects running up flights of stairs for periods of 2–12 min. Kristenson (*4*), on the other hand, found no significant change in the platelet count after exercise of moderate intensity that lasted 1.5–9 hrs. Differences in the type and duration of the exercise and in the technique of collecting the blood and making the platelet counts may account for these discrepancies. Our experience in counting platelets has convinced us that counts are unreliable unless they are made quickly after the sample is obtained and that the importance of meticulous technique cannot be overemphasized. The data in this paper represent a large number of platelet counts on one subject, in moderately good training, who performed at two standardized grades of exercise.

The exercise consisted in running on a treadmill for 5 min at a speed of 7 mph and a grade of 17.5% (strenuous exercise), or for 2 min at 12 mph, zero grade (exhausting exercise). The severity of the exercise was judged on the basis of the subjective impressions of the subject and the magnitude of the leucocytosis. The platelets were counted in a certified counting chamber using the diluting fluid of Rees and Ecker (*6*). Daily blank counts were made on the diluting fluid in order to avoid artifact errors. Leucocyte and erythrocyte counts were also made in most of the experiments. In each experiment platelet counts were made on blood samples obtained before exercise, immediately after exercise, and at intervals of 10, 30, 60, and 90 min during the recovery period.

The data on the platelet counts are recorded in Table 1. The data on leucocyte and erythrocyte counts are omitted because they are in accord with previous studies on exercise of comparable intensity (*5*). It is apparent that there was no increase in the platelet count in short periods of exercise.

TABLE 1

Effect of Brief Periods of Exercise on the Blood Platelet Count*

No. of experiments	Intensity of exercise	Blood platelets (thousands/mm^3)					
		Pre-exercise	Minutes postexercise				
			0	10	30	60	90
18	Strenuous	213 ± 15	208 ± 10	205 ± 18	201 ± 17	195 ± 18	196 ± 19
8	Exhausting	212 ± 13	198 ± 18	197 ± 17	200 ± 10	195 ± 15	197 ± 12

* The duration of the periods of strenuous exercise was 5 min and of the periods of exhausting exercise 2 min.

The lack of increase in the platelet count in these experiments, in spite of increases of 60–100% in the leucocyte count, may be interpreted as evidence against an appreciable storage or sequestration of platelets. The extreme fragility of platelets, however, renders them readily susceptible to mechanical trauma, and it is possible that the greatly increased circulation velocity during exercise may destroy enough platelets to mask a moderate increase in numbers. The small postexercise decline in platelet count seen in most of our experiments is probably to be explained on this basis.

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The Zone of Localization of Anti-Mouse-Kidney Serum as Determined by Radioautographs[1]

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It has been shown previously by Pressman and Keighley (*4*) that antiserum prepared against rat kidney actually localizes in the kidney after intravenous injection into a rat. This was accomplished by iodinating the globulin fraction of anti-rat-kidney serum, prepared according to the method of Smadel (*5*), with iodine containing tracer amounts of I^{131} and following the localization of the radioactivity in the kidney of the rat inoculated with this preparation. Similar results with mice have since been obtained with antiserum prepared against mouse-kidney tissue (*3*). By using iodine with a sufficient admixture of I^{131}, it has been possible for us to obtain radioautographs of the kidney tissue of mice injected intravenously with the radioiodinated globulin fraction of anti-mouse-kidney serum, and thus to determine more precisely the region of localization within the kidney.

In the experiment reported here, two mice were injected intravenously with the radioiodinated globulin fraction of anti-mouse-kidney serum prepared similarly to the radioiodinated globulin fraction of anti-rat-kidney serum described previously (*4*). Two control mice were injected with the radioiodinated globulin fraction of anti-mouse-plasma serum, prepared similarly, using the serum from rabbits which had been injected with mouse plasma. Such serum does not localize in the kidney as does the anti-mouse-kidney serum. Each mouse injected with the antikidney preparation received 0.3 ml of solution containing 3.3 mg of protein combined with 17 μc of radioiodine and, in the case of the mice injected with the antiplasma fraction, 4.8 mg of protein, combined with 13 μc of radioiodine in 0.3 ml of solution, was used. Five days after the injection the animals were sacrificed. A blood sample was obtained before death from the dorsal aorta, and then the kidneys, spleen, and liver were removed without perfusion. One kidney, one half of the liver and spleen, and all the blood were used in the preparation of samples for the determination of the radioactivity content of the tissue. The results are given in Table 1. The other kidney and the rest of the spleen and the liver were fixed in 10% formalin and subsequently sectioned. Sections 10-μ thick and the blocks remaining after several sections had been cut were used in the preparation of radioautographs. The blocks were set up on Eastman Kodak medium lantern slides, while the sections were set up on Ansco No Screen X-ray film, according to the method described by Marinelli and Hill (*2*).

TABLE 1

Radioactivity of Tissues of Mice Inoculated With Radioantisera 5 Days After Inoculation

	Antiserum used	
	Antikidney serum	Antiplasma serum
Protein inoculated (mg)	3.3	4.8
Radioiodine on protein at the time of injection (μc)	17	13
Tissue	Activity of tissue (μc/gram, 5 days after inoculation)	
Kidney	0.25	0.08
Liver	.08	.06
Spleen	.16	.13
Blood	.27	.21

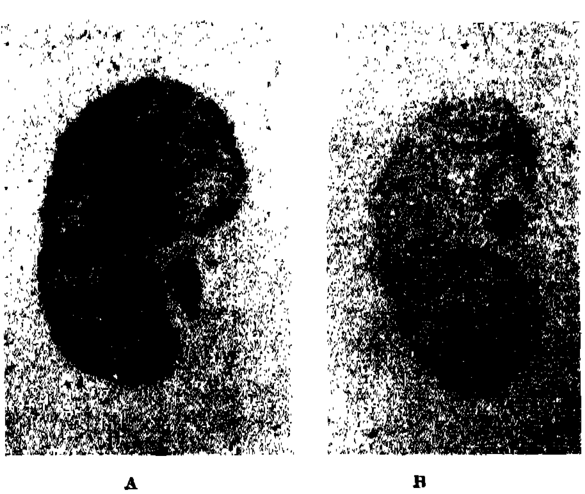

Fig. 1. Radioautographs of blocks of kidney tissue. A—from mouse injected with radioanti-mouse-kidney serum; B—from mouse injected with radioanti-mouse-plasma serum.

Fig. 1 shows the radioautographs of the kidney tissue blocks. The kidney from the mouse receiving the radioantikidney serum showed a definite accumulation of radioactivity around the cortex[3] (Fig. 1A) while the kidney from the mouse receiving the radioantiplasma serum showed no such accumulation (Fig. 1B). No accumulation was observed with either the liver or the spleen of the animals receiving the antikidney serum or the antiplasma serum. Fig. 2 shows the radioautographs of the kidney sections. In the sections from the animal receiving the radioantikidney serum there was a punctate accumulation of the radioactivity (Fig. 2A), while this was not the case for the kidney of the mouse receiving the radioantiplasma serum (Fig. 2B). Also, there was no such accumulation of radioactivity in the spleens or livers of the animals receiving either radioantikidney or radioantiplasma serum. With these tissues, very faint and diffuse radioautographs were obtained due to the radioactivity content of the blood in the organ.

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[1] This research was aided by grants from the Office of Naval Research and the American Cancer Society.

[2] Senior Fellow in Cancer Research, American Cancer Society Fellowship recommended by the Committee on Growth of the National Research Council.

[3] This is in accordance with the results of Heymann and Lund (*Science*, 1948, **108**, 448), who found that nephrotoxic antisera are produced from the cortical rather than the medullary kidney tissue.

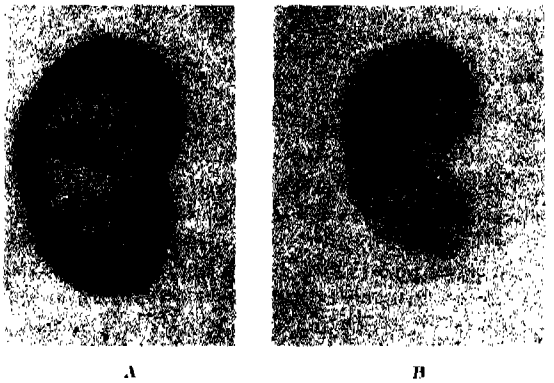

FIG. 2. Radioautographs of sections of kidney tissue. A—from mouse injected with radioanti-mouse-kidney serum; B—from mouse injected with radioanti-mouse-plasma serum.

Upon comparing the microphotograph of the kidney from the animals receiving the radioantikidney serum with an enlargement of the radioautograph, it was quite clear that the localization of the radioactivity and presumably the radioantibody was taking place in the glomeruli of the kidney. This point will be discussed more fully elsewhere (*3*).

The concentration of the antikidney serum in the glomeruli is not due to a nonspecific pickup by the kidney of foreign substances or to the fact that the radioactive material may pass through the kidney in its excretory path. The evidence for this is the fact that the radioantiplasma serum control contains substances of the same nature as radioantikidney serum, except for the specific kidney antibodies, and does not show any localization in the kidney. Similarly negative results were shown by a radioantiovalbumin serum. The radioactivity concentration in the various tissues for the two sera described here were quite similar except in the case of the kidney (Table 1). There the concentration of the radioactivity in the kidney of the animal receiving the radioantikidney serum was about three times that in the kidney of the animal receiving the control serum. The radioactivity in the kidney of the mouse receiving the control serum was essentially all due to the blood in the kidney, since mouse kidneys contain about 30–35% blood (*1*). The greater amount of radioactivity in the kidneys of the animal which received the antikidney serum must have been due to the kidney antibodies.

The localization of I^{131} in the glomeruli as shown by the radioautographs is probably a result of the corresponding localization of the specific antibodies to glomerular tissue.

These experiments were repeated with other preparations of radioantikidney serum with similar results.

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Growth of Potato Sprouts Retarded by 2,4,5-Trichlorophenoxyacetic Acid[1]

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Guthrie (*1*) first discovered that methyl ester of α-naphthalene acetic acid, when applied to potato tubers, retards the growth of sprouts. Many potato growers are now using this chemical on a commercial scale to prevent sprouting of potatoes in storage. Smith, Baeza, and Ellison (*2*) found during the 1945 season that this chemical also retards sprout growth of potatoes in subsequent storage when it is applied as a spray to the potato plants during the growing season. During the 1946 season the authors found that two spray applications of 2,4,5-trichlorophenoxyacetic acid (2,4,5-T), 25 ppm on July 19 and 50 ppm on August 20, retarded subsequent sprout growth of potatoes to the same degree as two applications of methyl ester of naphthalene acetic acid (MENA), 2,000 ppm on July 19 and 2,000 ppm on August 20.

In the spring of 1947 tubers of the Sebago variety were treated separately with MENA and 2,4,5-T in isopropyl alcohol and water and applied as a spray at the rate of 1 gm of chemical/bushel of potatoes. Although both chemicals significantly retarded sprout growth as compared with untreated tubers, sprouts of those treated with MENA had significantly less weight than those of tubers treated with 2,4,5-T.

During the 1947 growing season spray applications of sodium naphthalene acetate (sodium NA), 500, 1,750, and 3,000 ppm, compared with applications of sodium 2,4,5-T at 50, 175, and 300 ppm, were made to plants of the Sebago variety. The effect on sprout growth during subsequent storage at 50° F from October 25 to February 26 is shown in Table 1.

In all cases sodium 2,4,5-T retarded sprout growth to a greater degree than sodium NA, although the latter was applied in concentrations 10 times the former. There were no significant differences in yields of potatoes between any of the treatments.

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[1] Paper No. 301, Department of Vegetable Crops, Cornell University.

TABLE 1

WEIGHT OF SPROUTS PER TUBER
(Concentration of spray in ppm)

Date of application	Sodium NA 500	Sodium 2,4,5-T 50	Sodium NA 1,750	Sodium 2,4,5-T 175	Sodium NA 3,000	Sodium 2,4,5-T 300	Sodium NA Mean	Sodium 2,4,5-T Mean
	(gm)	(gm)	(gm)	(gm)	(gm)	(gm)	(gm)	(gm)
Aug. 1	2.30	1.70	2.27	1.22	2.27	0.87	2.28	1.26
Aug. 22	3.07	2.93	2.82	2.25	3.13	1.97	3.01	2.38
Sept. 10	3.22	2.73	3.13	2.75	3.10	2.83	3.15	2.77
Means	2.86	2.45	2.74	2.07	2.83	1.89	2.81	2.14
Untreated :		3.17 gm						

Sodium NA not significantly different from untreated at 19 : 1.
Sodium 2,4,5-T significantly lower than sodium NA or untreated at 99 : 1.

During the spring of 1948 potato tubers of the Houma variety were treated in open baskets in storage with dust forms of MENA (1 gm/bushel) and isopropyl ester of 2,4,5-T (0.9 gm/bushel). Both treatments significantly reduced the weight of sprouts produced; treatment with MENA, however, resulted in greater retardation than treatment with isopropyl ester of 2,4,5-T.

It was assumed that one of the reasons for less retardation of sprout growth by isopropyl ester of 2,4,5-T compared with MENA was due to lesser volatility of the former. During the storage season early in 1948 potato tubers were treated with the chemicals in dust form indicated in Table 2 and stored at 50° F for 10 weeks in closed paper bags to confine the volatile sprout retardant in the atmosphere immediately around the tubers.

TABLE 2

EFFECT OF TREATING POTATO TUBERS WITH SPROUT RETARDANTS

Treatment	Wt. of sprouts (gm/tuber)
1.0 gm of isopropyl ester 2,4,5-T/bushel	2.91*
0.5 " " " " " "	3.70*
1.0 " " MENA " "	1.46†
Untreated	10.81

* Significantly lower than untreated lots at odds 99 : 1.
† Significantly lower than any other treatment at odds 99 : 1.

To obtain information on the penetrability of 2,4,5-T into tubers and its subsequent reaction on sprout growth, the following experiment was conducted. Ten toothpicks soaked for one week in saturated solution of sodium 2,4,5-T were inserted about 1″ into each tuber. After storage for three months at 50° F, treated tubers were just beginning to sprout, whereas several sprouts 3″ to 4″ long developed on each of the untreated tubers (Fig. 1).

The toothpick technique was further employed to insure equal penetration of sodium NA and sodium 2,4,5-T into comparable sets of tubers. Aqueous solutions of 1,000 ppm of the two respective salts were used for soaking the toothpicks. One set of toothpicks was soaked in distilled water for comparison. After the picks were soaked 5 days they were inserted into Houma tubers of similar size and one series of untreated tubers (no toothpicks) was included as a control. Eight replications were used. Table 3 shows the effect of the above treatments on number and weight of sprouts. Single tuber plots were used and each value is the mean for 8 tubers.

FIG. 1. Left: Tubers pierced with toothpicks which had been soaked in a saturated solution of sodium 2,4,5-T (10 toothpicks/tuber). Right: Untreated control tubers.

TABLE 3

Treatments	No. of sprouts/ tuber	Wt. of sprouts/ tuber
Toothpicks soaked in sodium NA (1,000 ppm)	3.0	2.96
Toothpicks soaked in sodium 2,4,5-T (1,000 ppm)	5.0	2.61
Toothpicks soaked in distilled water	12.1	9.24
Untreated control (no toothpicks)	11.4	10.98

No significant difference was found between the sprout growth of tubers with distilled water-treated toothpicks and tubers with no toothpicks. Sprouting was reduced very significantly by both sodium NA and sodium 2,4,5-T, but no significant difference was found between the two in their effect on number or weight of sprouts. Further work is being conducted with other more volatile forms of 2,4,5-T to determine its practical value as a sprout retardant on a commercial scale.

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A New Dietary Factor Related to Xanthine Oxidase[1]

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Measurements of the xanthine oxidase activity in rat livers by the method of Axelrod and Elvehjem (*1*) have demonstrated that, in order to obtain normal liver xanthine oxidase levels on diets containing adequate riboflavin, two other dietary factors are essential. These are: (1) adequate protein, as originally indicated by McQuarrie and Venosa (*5*), and (*2*) an unidentified factor found in raw cream and liver, both good sources of xanthine oxidase.

Rats are born without any detectable xanthine oxidase activity in the liver, even when their mothers are on an adequate diet and have normal levels of xanthine oxidase in their own livers at the time of birth. Small amounts appear in the liver during the nursing period, and when the rats are weaned at 21 days of age, the average activity is 720 units ($C_{mm}O_2$/gm of dry liver/hr). This is less than half of the 1,550 units of activity found as an average for mature rats maintained on an adequate diet. If such weanling rats are placed on a diet containing 21% purified casein or 8% casein plus 13% peanut protein or 21% egg albumin plus biotin, the liver xanthine oxidase remains at approximately the starting level for 6 weeks. The 21% casein diet is given in Table 1; all other diets mentioned are identical except for the specific differences noted. When weanling rats are fed Purina dog chow (21% protein), the liver xanthine oxidase is brought to a normal level of 1,535 units in two weeks. If the Wesson oil and Crisco in the 21% purified casein diet are replaced by an equal amount of raw cream (6%), the liver xanthine oxidase activity of weanling rats is increased to 1,300 units in two weeks. If 5% dried whole liver replaces an equal weight of casein in the diet, the liver xanthine oxidase remains low for two weeks but is increased significantly after four weeks. Similarly, feeding a 21% crude casein diet does not affect the liver xanthine oxidase activity within two weeks, but gives levels of 1,260 units after four weeks.

TABLE 1

Casein (GBI Vit. Test)	21%
Crisco	4
Wesson oil	2
Cod-liver oil	1
Salt mix (Phillips and Hart)	4
Glucose	68
Choline chloride	100 mg%
Nicotinic acid	2.5
Ca pantothenate	1.0
Riboflavin	0.4
Thiamine	0.4
Pyridoxine	0.4

These experiments demonstrate that a 21% protein diet is adequate in providing the necessary protein for normal xanthine oxidase levels in the liver if another dietary essential is also incorporated in the diet in adequate amounts. In the relative absence of this unknown factor the starting levels of liver xanthine oxidase remain unchanged. When limited amounts of the factor are supplied, as with the liver and crude casein diets, the xanthine oxidase activity remains low for a period of time and then increases rather suddenly. Feeding a relative abundance of the factor, as with Purina dog chow and, to a lesser extent, the raw cream diet, gives a rapid increase to normal levels.

Rats fed an 8% casein diet (81% glucose) have essentially no xanthine oxidase activity in the liver after four weeks whether they were started as weanlings or were first brought to normal levels of activity by being fed Purina dog chow for two weeks. Rats brought to a zero level of xanthine oxidase activity by feeding them an 8% casein diet remain at the zero level when 6% raw cream replaces the Crisco and Wesson oil in the low-protein diet. Hence, supplying the dietary factor found in raw cream is ineffective in the absence of an adequate protein intake. Such zero levels of xanthine oxidase activity can be restored to normal by feeding dog chow; feeding the 21% purified casein diet allows a slower increase in the activity, indicating the presence of some of the unidentified factor in the diet containing purified casein.

The above experiments were carried out with animals obtained from Albino Farms. Sprague-Dawley rats have a lower xanthine oxidase level in the liver at weaning, averaging 430 units. They show considerably less individual variation at this time, but require appreciably longer dietary periods to bring the activity in the liver to normal levels.

Supplementing the 21% purified casein diet with biotin, inositol, *p*-aminobenzoic acid, pteroylglutamic acid, rutin, ergostanyl acetate, adenine, *d*-ribose, and additional riboflavin did *not* give normal xanthine oxidase levels in the liver. It is suggested that this dietary factor necessary for normal liver xanthine oxidase activity may be related to the unidentified component of the prosthetic group of xanthine and aldehyde oxidases (*2*, *3*, *4*).

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[1] Supported by a grant from the Nutrition Foundation, Inc.

Comments and Communications

The Miticidal Properties of Di (*p*-Chlorophenyl) Methyl Carbinol in Laboratory Insect Rearings

Controlling mites in cultures of insects has long been a problem in many laboratories. The use of the chemical di (*p*-chlorophenyl) methyl carbinol appears to offer a solution to this problem.

The highly specific miticidal action of di (*p*-chlorophenyl) methyl carbinol has proved useful in this laboratory for the control of species of mites, presumably *Tyroglyphus* and *Pediculoides* spp., infesting insect cultures. A dust, 2 per cent by weight, was prepared, using the technical product (supplied by The Sherwin-Williams Co., Agricultural Chemicals Division) and pyrophyllite. This preparation has completely eliminated mites infesting cultures of the pomace fly (*Drosophila melanogaster*), the webbing clothes moth (*Tineola bisselliella*), the confused flour beetle (*Tribolium confusum*), the American roach (*Periplaneta americana*), and the rice weevil (*Sitophilus oryza*) without producing any observable mortality in the egg, immature, or adult stages of these insects. In addition, the following insects have been completely covered with the dust without any deleterious effects: black carpet beetle larvae (*Attagenus piceus*), grouse locusts (*Tettigidae*), and the large milkweed bug (*Oncopeltus faciatus*).

Best results have been obtained by generously applying the dust to the insect itself, sprinkling upon the surface of the culture media, or by mixing the dust intimately with the culture media.

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Is There Laterite in Rocks of the Dakota Group?

During an inspection trip in Gage County Soil Conservation District, Nebraska, in 1943, the senior author noted the close similarity of certain beds of the Dakota group to the laterite of Buchanan. The material is a hard, cellular, slaglike "ironstone," ranging in color from red to yellowish brown and dark brown. In Gage County this material overlies reticulately mottled red and light-gray kaolinite clay beds of the Dakota group and of kinds that occur at several different horizons within the Dakota of Cretaceous age.

In the spring of 1948, C. G. Stephens, head of the Soil Survey of Australia, who was shown several outcrops in Saline and Ellsworth counties, Kansas, stated that some of the ironstone was closely similar to the "fossil laterites" of Australia, and that the mottled kaolinite clay beneath was also a typical companion material. Recently the authors have reviewed some of the literature on the Dakota formation, have studied many outcrops in Nebraska and Kansas, and have reached the following tentative conclusions: (1) that the Dakota group includes more than one horizon that contains material essentially like the laterite first described by Buchanan in India; (2) that this material probably represents a former subsoil horizon of an ancient soil; (3) that these ancient soils presumably were essentially like Marbut's groundwater laterite soils, described in the Amazon Valley, and were formed during periods when subsoil water fluctuated seasonally up and down in what is now a cellular ironstone.

Ground-water laterite soils occur most extensively, at present, under tropical climates with fluctuating, high water table or with periodic seepage. Climates with alternating wet and dry seasons are especially favorable to the formation of ground-water laterite soils, with their subsoil horizons of laterite. Present knowledge suggests that a long time is required for the formation of these soils.

According to various authors, the plant fossils of the Dakota group include persimmon, walnut, tulip tree, fig, laurel, sassafras, and others that suggest a somewhat warmer climate during the formation of the Dakota group beds of Nebraska and Kansas than the present one.

The writers have collected specimens and descriptions of laterite-like material and associated massive ironstones and kaolinitic clays from the Dakota group beds for further study. They expect to prepare a more detailed paper on the subject, and feel that a pedological interpretation will give a better understanding of the morphology and genesis of certain beds of the Dakota group than has been attained to date.

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On the Site of Discovery of the "Male Sterile" John Baer Tomato Mutant

In *Science* of May 14, 1948 (p. 506) the writer reported the finding of a new type of "self-sterility" applicable to hybrid tomato seed production. The site of find was not mentioned. This omission has had embarrassing consequences because a syndicated news rewrite of the article, rather excusably, implied the mutant was first observed at the West Tennessee Experiment Station. Actually it was first found, by the writer, in September 1945 while attending a field day at State College, Pennsylvania. It occurred as a single mutant rogue in a trial row of the variety John Baer growing in the horticultural plots at the Pennsylvania Agricultural Experiment Station. The plant was called to the attention of R. E. Larson, who kindly consented to share cuttings.

During the past year numerous requests for seed have come to the writer. To avoid possible duplication of effort by those interested in working with the plant, it is pointed out that this identical mutant has also been distributed by Dr. Larson.

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Book Reviews

Introduction to chemical thermodynamics. (2nd ed.) Luke E. Steiner. New York-London: McGraw-Hill, 1948. Pp. xiv + 510. $6.00.

This book has been prepared to introduce the subject of chemical thermodynamics, including the fundamental theory and application of the various useful thermodynamic functions to chemical systems. For this second edition a number of sections have been rewritten and new material has been added, including, particularly, expansion of the material on real gases and of the statistical calculation of thermodynamic functions. The author has made a strong effort to bring the text up to date from the standpoint of references to source data in the literature and to existing compilations on chemical thermodynamic properties. Those parts of the first edition, found through teaching experience to lack clarity or logic, have been rewritten. Latest values of the fundamental constants are used.

This book is recommended to those desiring an introduction to thermodynamics.

FREDERICK D. ROSSINI

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The recruitment, selection, and training of social scientists. (Bull. 58.) Elbridge Sibley. New York: Social Science Research Council, 1948. Pp. xv + 163.

To help orient the fellowship policies of the Social Science Research Council, in the face of the shortage of social scientists coincident with the expanding need for their services, Dr. Sibley undertook an analysis of the factors currently affecting the flow of personnel into the field. In his study, as is indicated in the title, problems of recruitment, selection, and training were given careful attention. The fourth component, employment outlook, was deliberately omitted on the assumption that with improvement in the other three aspects, competence, public recognition, and confidence will increase, and opportunities for professional employment will almost automatically improve.

The data utilized permit not only comparisons among the several social science disciplines but also cross-comparison with the natural sciences. Though this report interprets the data with respect to the conditions in the *social* sciences, those specializing in the natural sciences will find much to interest them.

The study of potential and actual recruits to the social sciences is comforting to the extent that it makes clear that not all the ablest members of the academic generation are being drawn away from the social sciences and that, man for man, the best social science graduate students are as bright as the best graduate students in the natural sciences. A warning note is sounded, however, by the larger proportion of those with apparently mediocre and inferior endowment in the social science group, as compared with the natural sciences. The pressure of the mediocre and inferior students apparently has had an undesirable effect on the quality of the training for the better-endowed undergraduate students majoring in the social sciences. The graduate departments in social science are, therefore, forced to begin their training at a level far lower than is done in other graduate science departments. In considering remedies, caution is indicated in the light of the large proportion of social science students who have no interest in careers as scientific researchers—the latter being the group with which Sibley has been most concerned in this study.

We cannot here review the full complement of the findings of this study or the variety of implications discussed. Anyone interested in the continued development of the social sciences should find this report worth reading. For those concerned with the training of future social scientists, it is a must.

EUGENE L. HARTLEY

The City College of New York

A symposium on the use of isotopes in biology and medicine. Madison: Univ. of Wisconsin Press, 1948. Pp. ix + 445. $5.00.

The twenty papers included in this book were presented as a symposium at the University of Wisconsin in September 1947. Nineteen scientists contributed, all of whom are most competent in their specialties. The University of Wisconsin committee, which arranged the symposium, is to be congratulated on the quality of the contributors and on the choice and arrangement of topics.

Hans T. Clarke opens the symposium with a brief account of the history of isotopes in biochemistry. This is followed by a group of 3 papers dealing with ways of obtaining isotopes: the means of separating stable isotopes (Harold C. Urey); the methods of preparing the numerous radioactive ones (Glenn T. Seaborg); and the availability of both stable and radioactive isotopes, particularly those distributed by the Atomic Energy Commission (Paul C. Aebersold). Next follows a group of 3 papers on the assay of isotopes. Alfred O. Nier deals with the detection of stable isotopes, with special reference to the mass spectrometer; Charles D. Coryell reviews the principles of measurement of radioactivity; and Martin D. Kamen describes the application of these principles to the assay of radioisotopes in biological material, with special emphasis on tritium (H^3), short-lived carbon (C^{11}) and long-lived carbon (C^{14}). These authors are followed by Donald B. Melville, who presents important examples of the synthetic procedures used in incorporating tracer atoms into organic molecules.

After the foregoing groups of articles dealing with techniques, there follow 6 reviews of results obtained with tracers: in protein metabolism (David B. Sprinson); in intermediary carbohydrate metabolism (Harland G. Wood); in intermediary metabolism of lipids (Konrad

Bloch); in mineral metabolism (David M. Greenberg); in iodine metabolism and thyroid function (I. L. Chaikoff and A. Taurog); and in general medicine (Joseph G. Hamilton).

Therapeutic applications of radioisotopes are described in two papers by Byron E. Hall (radiophosphorus) and by Saul Hertz (radioactive iodine). Health hazards in the use of radioisotopes are discussed by William F. Bale, primarily from the standpoint of the physicist, and by James J. Nickson from the standpoint of the physician. The book ends with thought-provoking essays by Harold C. Urey, on international aspects of atomic energy, and by Farrington Daniels, on the development and applications of atomic energy.

The book in general is clearly written. Although it was lithoprinted in order to speed production, it is quite legible. Errors are few, and these are concisely listed on a single sheet. The illustrations include photographs of all the contributors and the chairmen of the various sessions.

Although various other works on isotopes in biology have been and are appearing, the authoritative nature of most of the contributions to this book make it a most useful addition to the library of the "isotopic" biologist, particularly if he is interested in tracers.

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Chymia: annual studies in the history of chemistry. (Edgar F. Smith Memorial Collection: Univ. Pennsylvania, Vol. I.) Tenney L. Davis. (Ed.) Philadelphia: Univ. of Pennsylvania, 1948. Pp. xiv + 190. (Illustrated.) $3.50.

Situated at the University of Pennsylvania is one of the most important collections of rare books, prints, and manuscripts relating to the history of chemistry to be found anywhere in the United States. This collection was originally the private library of the late Edgar Fahs Smith, provost and historian of chemistry at the University. After his death in 1928, Mrs. Smith presented the library to the University, endowing it so that it might grow and flourish. This it has done, as several important collections have since been added to it, thereby enriching its resources.

With the recent publication of *Chymia*, one of Dr. Smith's dreams is brought to fruition, for he had wanted to establish a journal devoted to the history of the science with which his name was so long identified. As stated in the Introduction by Eva V. Armstrong, curator of the Smith Collection, "*Chymia* is intended to promote international scholarship in the history of chemistry, to bring a glimpse of the Edgar Fahs Smith Memorial Collection to those who would drop in for a visit some afternoon if it should be physically convenient to do so, and to provide a meeting ground for those who find pleasure in studies such as it reports." In spirit and in format this first volume of 13 articles admirably embodies the purposes expressed above.

The book opens appropriately enough with the last paper written by the late C. A. Browne (1870–1947), himself a distinguished historian of chemistry, whose library has very recently been added to the Collection. Browne's paper, "Recently acquired information concerning Fredrick Accum, 1769–1838," is a subject on which he had previously written. Claude K. Deischer follows with a memorial tribute to Dr. Browne and concludes with a bibliography of his writings on the history of chemistry—the list of 148 published and 17 unpublished papers speaks for itself. F. Sherwood Taylor transcribes and discusses an English alchemical poem, and Henry M. Leicester tells how Mendeleev promulgated the Periodic Law. Tenney L. Davis, well-known historian of pyrotechnics and editor of *Chymia*, provides an interesting account of the early use of potassium chlorate in the making of fireworks, and George Urdang, historian of pharmacy, writes learnedly and charmingly on the chemical and pharmaceutical history of calomel.

One of the most important contributions is a paper by Sidney M. Edelstein in which is published a hitherto unknown letter by Joseph Priestley. This appears to settle conclusively the famous controversy as to the parts played by Watt, Cavendish, Lavoisier, and Monge in discovering the chemical constituents of water.

It is evident that with this first volume of *Chymia* a new and important medium for the publication of studies in the history of chemistry and related sciences has appeared. May succeeding volumes continue on the high plane of scholarship and readability set by this first offering.

MORRIS C. LEIKIND

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Scientific Book Register

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NEWS and Notes

Beno Gutenberg, professor of geophysics and director of the California Institute of Technology Seismological Laboratory, and **Charles F. Richter**, associate professor of seismology, will attend the 7th Pacific Science Congress being held in New Zealand early in February. Both Dr. Gutenberg and Dr. Richter will present papers on special problems in seismology as related to the Pacific area.

Robert H. Cole, associate professor of chemistry, Brown University, will become the new department chairman July 1, following the resignation of **Paul C. Cross**. At that time Prof. Cross will assume his new duties as head of the Chemistry and Chemical Engineering Department at the University of Washington. **Donald F. Hornig**, assistant professor of chemistry at Brown, will become director of its Metcalf Research Laboratory.

Roger L. Geer of the College of Engineering at Cornell University has been appointed national chairman of the Committee on Inspection and Gaging for the Instrument Society of America. Prof. Geer, who initiated the first formal instruction in precision measurement at Cornell, supervises the Gage Laboratory which is being developed to include equipment for instruction and service to that area.

Frederick Wyatt was recently appointed chief psychologist at Cushing Veterans Administration Hospital, Framingham, Massachusetts. Dr. Wyatt will continue in his capacity as associate professor in the Clark University Department of Psychology.

Gerhard Herzberg and **Leslie E. Howlett**, of the National Research Council of Canada, became, respectively, director and associate director of the Division of Physics, effective January 1. Dr. Herzberg, former professor of spectroscopy at the Unversity of Chicago, had been acting as a principal research officer. In his new position he succeeds **R. W. Boyle**, who retired last October. Dr. Howlett has been in charge of optics on the NRC staff since 1931.

M. H. Harnly, of Washington Square College, New York University, will address the Section of Biology of the New York Academy of Sciences February 14 at 8 P. M. on the subject "A Morphological Interpretation of the Effect of Temperature Upon Development."

Clarence E. Davies, executive secretary of the American Society of Mechanical Engineers, was recently appointed a term trustee of Rensselaer Polytechnic Institute.

Wallace Richards, formerly assistant director of the Carnegie Museum, Pittsburgh, Pennsylvania, assumed the duties of director January 1, upon the retirement of **O. E. Jennings**. Dr. Jennings has been made director emeritus of the Museum.

Lawrence H. Gahagan, of New York City, has been appointed consulting psychiatrist in the Department of Health and Hygiene, Vassar College. Dr. Gahagan was at one time an assistant professor of psychology at the University of California, Los Angeles.

Visitors to U. S.

J. C. Saha, of the Department of Botany and Mycology, Presidency College, Calcutta, India, who has until recently been acting as visiting research fellow in forest pathology at Yale University is now en route to India, making visits to English and French institutions on the way. During the past two years Dr. Saha has been visiting various U. S. and Canadian universities and state agricultural experiment stations, completing his Ph.D. requirements at West Virginia University.

Leslie Paul Greenhill, chief technician of the Visual Aids Centre, University of Melbourne, was recently appointed research assistant on the staff of the Instructional Film Research Program at Pennsylvania State College. Mr. Greenhill recently arrived from England where he spent a year in study of the production and utilization of instructional films and, while there, represented Pennsylvania State College at the second annual Congress of the International Scientific Film Association.

Rudolf Florin, director of the Botanical Garden, Stockholm, Sweden, (*Science*, Oct. 15, p. 406), has been presenting a seminar series at the University of California, Berkeley, on the nature of the female reproductive organs in fossil Cordaites, Coniferales, and Taxads. Before arriving on the West Coast, Dr. Florin had given the Prather Lectures at Harvard.

Grants and Awards

National Cancer Institute grants totalling $1,319,483, have been announced by the Federal Security Administrator, Oscar R. Ewing, following recommendations of the National Advisory Cancer Council. These grants, which have been approved by Leonard B. Scheele, Surgeon General of the Public Health Service, will aid in laboratory and clinical cancer research, cancer control projects, and cancer teaching in medical and dental schools.

Of the 50 grants approved for laboratory and clinical research in 15 states, the District of Columbia, and three foreign countries, 18 are new and 32 continuous. The research projects include investigations of possible therapeutic agents; metabolism studies of cancer, using such techniques as tracing by radioactive isotopes; physiologic and pathologic investigations of stomach cancer; studies on the production of cancer in experimental animals, with emphasis on the determination of possible causative agents; and comparative examinations of tissues and sera in normal and malignant states. The 11 grants for cancer control went to nonfederal institutions and agencies to support studies of cancer diagnostic tests, environmental cancer, tumor pathology, cancer teaching methods, and other special control projects. Grants to continue cancer teaching of undergraduates went to 23 medical schools and 9 dental schools.

The first Philip A. Benson Fellowship Award for medical research has been announced by J. A. Curran, president of the Long Island College of Medicine. The award commemorates the late Philip A. Benson, former president of the Dime Savings Bank of Brooklyn. The recipient of the fellowship is Irving Rappaport, instructor at the College, who has had training and experience as a malariologist and parasitologist in tropical medicine in Australia, New Guinea, and the Philippines.

The West Virginia Agricultural Experiment Station has received a grant of $4,000 for the year 1949 by Swift and Company, Chicago, for continuation of Burch H. Schneider's studies on the digestibility and composition of feeding stuffs by farm animals.

Morris S. Kharasch, Carl William Eisendrath Professor of Chemistry at the University of Chicago, has been selected to receive a John Scott Award in recognition of his outstanding work in the field of alkyl mercurials. Dr. Kharasch first suggested the use of such compounds as ethyl mercury chloride as seed disinfectants and developed improved reactions for their synthesis, leading to greatly increased yields of cotton, corn, wheat, and other crops. The award, consisting of $1,000 and a copper medal, will be presented to Dr. Kharasch at a dinner of the Delaware Section of the American Chemical Society at the Hotel du Pont, Wilmington, Delaware, on Wednesday, January 26.

Fellowships

Bryn Mawr College announces the availability of the following fellowships and scholarship awards in sciences in its Graduate School for 1949–50: Department of Geology—one resident fellowship ($1,250), one or two resident scholarships ($650), two demonstratorships ($1,000); Department of Chemistry—one resident fellowship ($1,250), one or two resident scholarships ($650), several demonstratorships ($1,000); Department of Physics—one or two resident scholarships ($650), one or more research assistantships ($750–$1,000), two demonstratorships $1,000); Department of Mathematics—one resident fellowship ($1,250), one or two resident scholarships ($650), readership ($700); Department of Psychology—one resident fellowship ($1,250), one or two resident scholarships ($650), one demonstratorship ($1,000); Department of Biology—one resident fellowship ($1,250), one or two resident scholarships ($650), two half-time demonstratorships ($1,000 each). Three scholarships ($700) are offered to qualified students who wish to continue study in fields such as biochemistry, biophysics, crystallography, geochemistry, geophysics and psychophysics and two fellowships ($1,250) to candidates in the same fields.

Applications should be in before *March 1.* Full information and blanks may be obtained by writing to the Office of the Dean of the Graduate School, Bryn Mawr College, Bryn Mawr, Pennsylvania.

Armour Research Foundation of Illinois Institute of Technology has announced the availability of several industrial research fellowships starting September 1949, in the fields of physics, chemistry, chemical, mechanical and electrical engineering, metallurgy, ceramics, and applied solid and fluid mechanics. During the school terms half-time graduate study will be provided, tuition free, in the Graduate School of Illinois Institute of Technology concurrently with half-time research employment in Armour Research Foundation (and full-time employment in the intervening summer), equivalent to a total stipend of about $3,750. Appointments will be announced *March 15,* 1949, prior to which time information and application blanks may be obtained from the Dean of the Graduate School, Illinois Institute of Technology, Technology Center, Chicago 16.

Colleges and Universities

The physiological and psychological effects of arctic temperatures will be studied by a group of University of Washington scientists for the next two years. Operatng under a contract from the Air Surgeon's Office of the USAF, an expedition left for Alaska on January 15 to establish headquarters at the Arctic Aeromedical Laboratory at Ladd Field, Fairbanks. Investigations for the project, which is being directed by Loren D. Carlson, of the Department of Physiology and Biophysics, will be conducted by three research teams. One, composed of physiologists, electronics engineers, mechanical engineers, physicists, and chemists, will study the effects of arctic temperature on the body; another will be concerned with fatigue, performance, and mental phases of the problem; and the third will study arctic animals to learn if factors of animal survival can be applied to humans.

North Carolina State College has announced plans for the construction of a $1,245,000 Engineering Laboratories Building. Equipped with the latest devices for instruction, research and industrial service, the building will contain X-ray equipment, high-voltage electrical apparatus, and complete ceramic and structural clay investigation machinery. J. H. Lampe, dean of the School of Engineering, estimates that it will be completed not later than June, 1950 and will be one of the most modern structures of its type in the country.

The Daniel and Florence Guggenheim Jet Propulsion Centers will be established at Princeton University and the California Institute of Technology to provide facilities for postgraduate education and research in jet propulsion and rocket engineering. The two centers have been underwritten by the Daniel and Florence Guggenheim Foundation for seven years with an appropriation of $500,000, to be used to pay salaries of professors, fellowships of graduate students, and similar expenses. Buildings and equipment will be provided by the universities. The principal post in each center will be a Robert H. Goddard professorship, named for the late Robert H. Goddard, of Clark University. Caltech's Goddard professor will be Dr. Hsue-Shen Tsien, 38-year old native of China, now professor of aerodynamics at MIT.

A study of the problems of growth and differentiation by critical discussion has been undertaken by research workers at Amherst, Mt. Holyoke, and Smith Colleges, and the University of Massachusetts. The members are: Virginia C. Dewey, Taylor Hinton, George W. Kidder, Robert E. Parks, Jr., Harold H. Plough, and Oscar E. Schotté, of Amherst College; A. Elizabeth Adams and Christianna Smith, of Mt. Holyoke College; Albert F. Blakeslee, Jacob Rappaport, S. Meryl Rose, and Sophie Satin, of Smith College; and David W. Bishop and Gilbert L. Woodside, of the University of Massachusetts.

Industrial Laboratories

Per K. Frolich, director of research and Development for Merck & Company, Inc., has been appointed vice-president for Research and Development, to succeed **Randolph T. Major,** who will continue as director of all scientific activities of the Company.

Eastman Kodak Company has announced the availability of nitrogen 15 in the form of either nitric acid or potassium nitrate. The company has been supplying N^{15} in the form of ammonium salts and as potassium phthalamide in concentrations up to 60 atom per cent N^{15}. The ammonium nitrate has N^{15} in the ammonium radical only. The nitric acid will be supplied as an aqueous solution containing at least two moles per liter; the potassium nitrate is available as a dry solid.

The Polytechnic Research and Development Company, Inc., formerly located at 66 Court Street, Brooklyn, New York, announces the opening of new and expanded research laboratories at 202 Tillary Street, Brooklyn, New York. The concern is headed by H. S. Rogers, president of the Polytechnic Institute of Brooklyn, and is under the technical direction of F. J. Gaffney.

Studies of cosmic rays and nuclear forces will be furthered by the new 16-bev bevatron, for which the electrical equipment is now being built by the Westinghouse Electric Corporation, with funds provided by the Atomic Energy Commission under its pure research program. The new machine, to be installed on the Berkeley campus of the University of California, will be 17 times more powerful than the University's present cyclotron. The electrical equipment will consist of two alternating-current motor-generator sets, each capable of developing 50,000 kilowatts; Ignitrons to change alternating into direct current electrically; and a network of controls and meters to channel the power into a 10,000-ton circular steel magnet.

Pyridium Corporation, of Nepera Park, New York, announces the appointment of **Roland G. Benner** as director of Development and Engineering. For the past 19 years Mr. Benner had been associated with E. I. du Pont & Company of Wilmington, Delaware, in various capacities, his most recent being in charge of the Applied Process Control Group.

Meetings and Elections

The Spectroscopy Society of Pittsburgh is sponsoring the 9th Pittsburgh Conference on Applied Spectroscopy on February 18 and 19 at Mellon Institute Auditorium, Pittsburgh, Pennsylvania. The Chairman for absorption spectroscopy papers is Joseph Lieblich, Mellon Institute; for emission spectroscopy papers, Joseph Geffner, Weirton, West Virginia.

Plans for the 30th Annual Meeting of the American Geophysical Union, April 20–22, 1949, Washington, D. C., provide for sessions for all Sections, as well as a general session and joint sessions of two or more Sections. Papers are invited for the Sections on Geodesy, Seismology, Meteorology, Terrestrial Magnetism and Electricity, Oceanography, Volcanology, Hydrology and Tectonophysics. Further information regarding submission of titles and abstracts may be obtained from the office of the American Geophysical Union at 1530 P Street, N.W., Washington, D. C. Comments relating to papers and symposia bearing on more than one Section will be welcomed. They should be addressed to J. P. Marble, Chairman of the Committee on Meetings, U. S. National Museum, Washington 25, D. C. Members planning to attend the meetings are urged to make their hotel reservations promptly directly with the hotel as the Committee has no facilities for handling these.

Regional meetings have been planned for these dates: February 4–5, Los Angeles; April 26–27, Denver.

The 1st International Congress of Biochemistry will be held in Cambridge, England, August 19–25. Officially recognized by the International Union of Chemistry, the Congress is an outgrowth of meetings of biochemists from many countries, which the Société de Chimie Biologique has organized from time to time in the past. The success of these meetings indicated the desirability of a full international congress of biochemistry. In addition to the meetings of the 11 Sections of the Congress, there will be Congress lectures and visits to research stations and laboratories. Further details for those wishing to join the Congress may be secured from Lt. Col. Francis J. Griffin, Honorary Organiser, 56 Victoria Street, London, S.W. 1. Arrangements have been made to house a limited number of visitors in the colleges of university, however, early reservations are requested.

The 2nd Inter-American Congress of Brucellosis was held under the auspices of the Pan-American Sanitary Bureau at Mendoza and Buenos Aires, Argentina, November 17–26. The U. S. was officially represented by James H. Steele, Chief, Veterinary Public Health Division, Communicable Disease Center, U. S. Public Health Service, who was named chairman of the delegation, and C. K. Mingle, assistant chief, Tuberculosis and Brucellosis Eradication Division, Bureau of Animal Industry. The meeting at Mendoza was devoted to research and epidemiology papers, while that at Buenos Aires was mainly concerned with discussion of the diagnosis and therapy of human brucellosis.

Two permanent committees were created to study the problems of standardization of human serological diagnostic methods and animal disease eradication, the success of both depending upon having a standard antigen with which to compare others. It was believed that the antigen of the Bureau of Animal Industry, U. S. Department of Agriculture, would be the best standard to use as it is available in large quantities and could be readily distributed. Similar studies will be conducted on animal serology. The Congress agreed that the control of the disease in animals was the first step toward controlling it in humans.

The 2nd Inter-American Congress on Brucellosis voted to accept the invitation of the U. S. to hold the next Congress in Washington, D. C., in October 1950. William W. Spink, of Minneapolis, has been named chairman of the 3rd Inter-American Congress on Brucellosis and M. Ruiz Castaneda will continue as Secretary.

James B. McNaught, professor of pathology at the University of Colorado School of Medicine and head of the Department of Pathology at the Medical Center, was named president elect of the American Society of Clinical Pathologists at their annual scientific meeting in Chicago last October. Dr. McNaught will serve during 1949.

The U. S. National Committee of the International Commission of Optics (an affiliate of the International Union of Pure and Applied Physics), has been reconstituted and enlarged since its first formal meeting held at Delft, Holland, in July 1948. The present membership of the committee is: Stanley S. Ballard (chairman), Department of Physics, Tufts College; Irvine C. Gardner, National Bureau of Standards; Max Herzberger, Eastman Kodak Company; Herbert E. Ives, Bell Telephone Laboratories (retired); F. A. Jenkins, University of California, Berkeley; Deane B. Judd, National Bureau of Standards; Rudolf Kingslake, Eastman Kodak Company; George Wald, Harvard University; and Mary E. Warga, University of Pittsburgh.

Rustin McIntosh, Carpentier Professor of Pediatrics at the College of Physicians and Surgeons, Columbia University, was recently elected the 1949 chairman of the American Council on Rheumatic Fever of the American Heart Association.

The Division of Colloid Chemistry, American Chemical Society, recently elected the following new officers: Desiree S. Le Beau, director of research, Midwest Rubber Reclaiming Company, East St. Louis, chairman; Sydney Ross, of the Renasselaer Polytechnic Institute, chairman-elect; W. O. Milligan, Rice Institute, secretary-treasurer (re-election) and divisional representative on the Society's National Council; and Alfred J. Stamm, Forest Products Laboratory, USDA, Madison, Wisconsin, and John D. Ferry, University of Wisconsin, members of the Division's executive committee.

Dr. Le Beau, the first woman to head the Division, succeeds Robert D. Vold, of the University of Southern California, who was elected to the Division's Colloid Symposium Committee.

The Twelfth Annual Tri-States Geological Conference was held in northeastern Iowa on October 23 and 24. More than 250 geologists from Illinois, Wisconsin, and Iowa traveled the 150-mile conference route, which roughly followed the Mississippi River, from Lansing to Bellevue. Eleven stops were made to afford the participating geologists an opportunity to see the full geologic section from the upper part of the Cambrian Franconia formation to the Silurian Hopkinton formation. In addition, geomorphic, topographic, and other allied features were observed in this almost driftless, but not unglaciated, area. A guidebook containing geological discussions, well logs, maps, and stratigraphic sections, together with an annotated road log, was furnished each participant.

New members of the Executive Committee elected to represent their respective states for the next 3 years were: E. C. Dapples, succeeding J. Harlan Bretz for Illinois; F. T. Thwaites, succeeding L. M. Cline for Wisconsin; and C. H. Roy, succeeding H. Garland Hershey for Iowa. The 1949 conference will be held in Illinois under the chairmanship of Dr. Dapples.

Deaths

Brent S. Drane, 67, consultant and deputy member of the Hydrology Panel, Research and Development Board, who had served as civil engineer in various state and federal government capacities, died November 22 at his Chapel Hill, North Carolina, home.

Karl Bonhoeffer, 80, former professor of psychiatry at Berlin University, died in Berlin, Germany December 4. Last May Dr. Bonhoeffer became an honorary member of the Amercan Psychiatric Association, the first German scientist to be so honored since World War II.

Albert K. Epstein, 58, consulting chemist and president of Emulsol Corporation, Chicago, died December 22 in Tel Aviv, Israel.

Homer W. Hillyer, 89, retired chemical engineer and former professor of organic chemistry at the University of Wisconsin, died in Farmington, Connecticut on January 3.

Clyde Fisher, 70, ex-chief curator of Hayden Planetarium and participant in expeditions to the Arctic Lapland, Siberia, Mexico and Peru, died in Doctors Hospital, New York City on January 7.

C. K. Edmunds, 72, president emeritus of Pomona College, was killed in an automobile accident in Claremont, California, on January 9. From 1903–24 Dr. Edmunds was professor of physics and electrical engineering at Canton Christian College, China, and later became provost of Johns Hopkins University.

The origin of the Pacific atolls is the subject of further study made possible by the loan by the British Museum to the U. S. National museum of two tons of rock specimens drilled from Funafuti Atoll. Cornell University reports that the specimens taken from an 1,100-foot boring on Ellice Island, put down by a joint expedition of the Royal Society of London and the Australian Government in 1896, will be compared with rock from deep borings made on Bikini Atoll following the atomic bomb tests in 1947 (see *Science*, January 16, 1948).

John W. Wells, of the Department of Geology of Cornell University, conducted the negotiations with the British Museum at the suggestion of Harry S. Ladd, of the Basic Sciences Section of the U. S. Geological Survey, who expressed the thought that improved instruments and new techniques for geological interpretation might produce new facts from specimens last examined 50 years ago. The studies will be made in Washington, D. C., where the Bikini material is housed, by members of the Geological Survey and geologists from Cornell and other cooperating institutions.

In 1889 Charles Darwin advanced the theory that the Pacific atolls are the vestiges of volcanic islands which have subsided into the sea. Study of Funafuti borings did not settle the matter and samples were stored in the British Museum, where they rested until shipped to Washington last November. Preliminary investigation indicates that the Bikini rock is sand-like in nature, quite different from the Funafuti material, and also different from the volcanic rock which Darwin had predicted. The two atolls are only 1,500 miles apart, but evidence seems to indicate that the Funafuti rock is not more than 25,000 years old and that from Bikini 10,000,000–15,000,000 years old.

The U. S. Atomic Energy Commission has adopted a formal personnel policy which exempts its positions from competitive Civil Servce and establishes an independent merit system. Personnel will receive the same leave and retirement benefits as are now granted federal employees. The new policy succeeds a series of temporary arrangements in effect since January 1, 1947, when the AEC took over management of the national atomic energy program from the Manhattan Engineer District of the U. S. Army.

A Book Coupon Scheme was recently launched by UNESCO on a one-year experimental basis to enable educators, scientists and professional people in war-devastated countries to obtain needed periodicals, text and reference books on education, science and culture from other countries. In special ceremonies at Unesco House, $150,000 in coupons was initially delivered to representatives of the participating countries: Austria, China, Czechoslovakia, France, Greece, Hungary, India, Italy, Indonesia, Iran, the Philippines, Poland and the United Kingdom. The coupon scheme will enable groups in these countries to buy publications from so-called "hard-currency" countries like the United States, while making payments in their own national currency. In each participating country special Distributing Bodies have been appointed for the sale of book coupons and as information centers for questions relating to the program. The American Booksellers Association has been appointed to administer the UNESCO program in the United States.

Methods of presenting atomic energy to high school students were considered at the New England School Science Council Atomic Energy Workshop, held in Boston December 27–31. The workshop, under the direction of Fletcher G. Watson, chairman of the New England School Science Council, and sponsored by the Boston Museum of Science and the American Academy of Arts and Sciences, was composed of U. S. Atomic Energy Commission officials, nuclear scientists and 50 New England high-school science teachers. Among the USAEC officials who took part were Shields Warren, director, Division of Biology and Medicine; Morse Salisbury, director, Division of Public and Technical Information Service; and George Glasheen, assistant director in charge of Public Education in the Information Service. Scientists participating represented MIT, Harvard University, Arthur D. Little Company, and Brookhaven National Laboratory. Besides developing methods of teaching atomic energy in the New England schools, the workshop may serve as a model for other atomic energy workshops now being planned across the country.

Make Plans for—

American Geophysical Union, 23rd regional meeting, February 4–5, University of California, Los Angeles.

American Society of General Physiologists, regional meeting, February 5, Washington Square, New York University, New York City.

American Mathematical Society, February 26, meetings in New York City and Chicago.

5th International Congress for Comparative Pathology, May 17–20, Istanbul, Turkey.

Recently Received—

Centri-Die Castings. New booklet available on request from the Lebanon Steel Foundry, Lebanon, Pennsylvania.

Catolog No. 7 of Edwards Brothers, Inc., Ann Arbor, Michigan (listing of 700 foreign scientific and technical books and sets reproduced by license of the Office of Alien Property).

Immunity Bulletin, May 1946–April 1947. A synopsis of researches at the Bengal Immunity Laboratory, Calcutta, published by the joint secretaries, Immunity Scientific Association, 39 Lower Circular Road, Calcutta 16.

The story of soap. Illustrated pamphlet issued by the Procter & Gamble Company, Cincinnati, Ohio.

High school: what's in it for me? Prepared by the Office of Education and produced through courtesy of American Technical Society, Drexel at 58th Street, Chicago 37, Illinois, from which copies are available.

The Story of Norge. Illustrated pamphlet available through Borg-Warner Corporation, Detroit, Michigan.

Postgraduate education in high school 1947–48, by Homer Kempfer. (Pamphlet No. 106, Office of Education.) Washington, D. C.: U. S. Government Printing Office, 1948. $.10.

The animal protein factor, by Ruth Woods. In *Borden's Review of Nutrition Research,* Vol. IX, No. 8, October 1948.

Tracerlog. House organ of Tracerlab, Inc., 55 Oliver Street, Boston 10, Massachusetts.

Air conditioning design, by H. C. Hoffmann and G. B. Priester. Application data booklet (AD 44) published by the American Society of Refrigerating Engineers, 40 West 40th Street, New York City. Copies available at $.40 each.

Report of the president of the Johns Hopkins University, 1947–48.

Bovine plasma proteins. An annotated bibliography prepared expressly for scientists and medical specialists by the staff of the Chemical Research and Development Department of Armour and Company, Chicago 9, Illinois. Available upon request to above address.

The History of Oxygen

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TO A CHEMIST, OXYGEN IS ONE of the most interesting elements of the earth because of its remarkable reactivity, its paramagnetism, its participation in living processes, its use as the standard for atomic weights, and, finally, its great abundance in the earth's crust. The origin of oxygen not only as an element, but as a free gas in the earth's atmosphere, and the sequence of events which oxygen now undergoes as it passes through the carbon and other cycles, constitute the history of oxygen, a subject about which we may never know with certainty all of the details, although the broad aspects of some of its history seem at the present time to be clear.

The three stable isotopes of oxygen, masses 16, 17, and 18, presumably were initially formed from the primordial flux of neutrons (called by Alpher the "ylem") which was the precursor of all matter. Alpher, Bethe, and Gamow (*1*) have recently published a neutron-capture theory of the formation and relative abundance of the elements which makes plausible, from a semiquantitative point of view, the idea that all the elements were initially formed in the same event, by the decay of neutrons to protons and electrons and by the capture of neutrons and protons by each other to form the various known nuclei. Given the formation of oxygen by this mechanism, we now proceed to discuss the history of oxygen on our own planet.

A problem which challenges our imagination is that of explaining the existence of free uncombined oxygen in our atmosphere. D. ter Haar (*12*) has recently reviewed theories of the origin of our solar system and presented a new modified theory of his own which comes the closest of all extant theories to explaining quantitatively the known facts. He starts with the simplest possible hypothesis, originally proposed by Kant, namely, a sun surrounded by a gaseous envelope. Condensation nuclei formed near the sun will be inorganic compounds of heavy elements (that is, heavier than hydrogen and carbon); hence the inner planets will be small and dense. They will have acquired their size before gravitational capture of matter from the gaseous envelope has become important. The outer planets, however, would be formed in a relatively cold region of the envelope so that organic as well as inorganic compounds could form and condense. The outer planets, therefore, will be of small density, but will grow to large size because of gravitational capture.

During the process of condensation, the earth seems to have lost practically all of the light elements which could not be bound chemically; for example, as Unsöld (*24*) has pointed out, in the star τ Scorpii, neon and nitrogen are about equally abundant, and their abundance does not fall much short of that of oxygen, whereas in the earth's atmosphere the abundance of neon is almost negligible. If neon of atomic weight 20 could not be held by the earth, neither could water vapor of mass 18, nor atomic oxygen of mass 16. Argon of mass 40 and molecular oxygen of mass 32 would be much more likely to be captured. However, because of the reactivity of oxygen it is almost inconceivable that the earth's atmosphere when first formed could have contained this element in its uncombined state. Water must have been held in combination with inorganic compounds, most of which are readily hydrated or which adsorb water to some extent. As the matter condensed to create the earth, the potential energy of the gaseous envelope was undoubtedly transformed into heat, raising the temperature of the growing nucleus. Inasmuch as the melting point probably rises more rapidly with the pressure in the interior of the earth than does the temperature, the earth would solidify first within, followed by a gradual consolidation proceeding outward (see discussion in *29*). This heat would cause water to be driven out, but if the planet had accumulated enough mass at this point, the water would be held in the gravitational field. In 1924 Tammann (*23*) calculated that even at as high a temperature as 1,500° K the fraction of water molecules having velocities equal to or greater than the "escape velocity" was only 1.4×10^{-75}, a negligible fraction. Nitrogen and carbon dioxide would collect in the atmosphere on being driven out of the hot magma, in much the same way as water. In addition to being fixed in water and carbon dioxide, we find oxygen in the earth's crust also in the form of oxides and silicates, but we shall not be concerned here with the history of oxygen in these compounds.

We come now to the period of oxygen's history beginning with the earth after it had cooled from its original molten state. The most important fact that

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Adapted from an address delivered as the retiring president of the Northwestern Chapter of Sigma Xi, October 20, 1948.

confronts us is the present existence of oxygen in the atmosphere; there are those, such as the Russian biochemist Oparin (*18*), who believe that life was first created on the earth by processes not involving free oxygen, such as the slow formation in the oceans of small organic molecules, then larger polymers, then colloidal particles, such as tactoids or coacervates, and finally living organisms. These living organisms then began to photosynthesize, thus creating the oxygen of the atmosphere by the dehydrogenation of water. The difficulty with this theory of Oparin's is that it cannot be checked by the application of known physicochemical principles, because of our present ignorance concerning not only the mechanism of the origin and production of life, but also of the details of the photosynthesis process. Tammann (*23*) believed that oxygen arose through the thermal dissociation of water followed by escape of hydrogen from the atmosphere, but for this process to have been significant the temperature of the water vapor must have exceeded 1,500° K (to produce appreciable dissociation).

In the higher regions of the earth's atmosphere, in the stratosphere, the ultraviolet light from the sun is much more intense than at the earth's surface, producing at a height of 25 km a maximum in the partial pressure of ozone, according to the photochemical reaction

$$O_2 + h\nu \rightarrow O_2^* \rightarrow O + O \qquad (+5.08\ \text{ev}) \qquad (\mathit{1})$$
$$O + O_2 + M(N_2?) \rightarrow O_3 + M \qquad (-1.03\ \text{ev}) \qquad (\mathit{26})$$

(Reaction numbers are those of Table 1.) It is this layer of ozone which prevents practically all of the light of wave length shorter than about 3,000 A from reaching the earth. But above 50 km very little ozone is present, so that we may assume that in this region of the stratosphere and at higher levels in the ionosphere, the gas present is exposed to solar radiation of wave length even as short as 600 A. It is important to consider possible photochemical as well as ionization processes which may have given rise to free atmospheric oxygen as suggested by Poole (*19*). In Table 1 we have listed all of the processes, photochemical or ionic, which are believed to exist or to be capable of existing in the stratosphere or ionosphere. It is a relatively simple matter to write a sequence of reactions which can produce oxygen; for example, water and oxygen on dissociation produce fragments which could react as follows:

$$H_2O + h\nu \rightarrow H + OH \qquad +5.12\ \text{ev} \qquad (\mathit{12})$$
$$O_2 + h\nu \rightarrow O + O \qquad +5.08\ \text{ev} \qquad (\mathit{1})$$
$$O + OH \rightarrow O_2 + H \qquad -0.69\ \text{ev} \qquad (\mathit{22})$$
$$OH + OH \rightarrow H_2O + O \qquad -0.61\ \text{ev} \qquad (\mathit{9})$$

or

$$OH + OH \rightarrow H_2 + O_2 \qquad -0.69\ \text{ev} \qquad (\mathit{14})$$

If the hydrogen of reactions 3, 17, and 19 has thermal energies greater than 1,000 or 1,500° K, it will be quickly lost, leaving an excess of free oxygen in the atmosphere. Poole (*19*) has estimated that, at a tem-

TABLE 1

POSSIBLE PHOTOCHEMICAL AND IONIC PROCESSES OF THE STRATOSPHERE AND IONOSPHERE*

Reaction No.	Reaction	Energy absorbed (+) or liberated (−) in ev	Reference
	Endothermic Photochemical Reactions		
1.	$O_2 + h\nu \longrightarrow O + O$	+5.08	(*13*)
2.	$O_2 + h\nu \longrightarrow O\ (^1D) + O$	+7.05	(*10*)
3.	$H_2O + h\nu \longrightarrow H + OH$	+5.12	(*13*)
4.	$N_2 + h\nu \longrightarrow N + N\ (^2D^o)$	+9.75	(*17*)
5.	$CO_2 + h\nu \longrightarrow CO + O\ (^1D)$	+7.47	(*17*)
6.	$CO + h\nu \longrightarrow C + O$	+9.14	(*13*)
	Endothermic Ionizing Reactions		
7.	$O_2 \longrightarrow O_2^+ + e$	+12.2	(*22*)
8.	$O_2 \longrightarrow O + O^+ + e$	+18.65	(*22*)
9.	$H_2O \longrightarrow H_2O^+ + e$	+12.7	(*22*)
10.	$H_2O \longrightarrow H + OH^+ + e$	+18.4	(*15*)
11.	$H_2O \longrightarrow H + H + O^+ + e$	+23.1	(*15*)
12.	$H_2O \longrightarrow H_2 + O^+ + e$	+18.6	(*15*)
13.	$N_2 \longrightarrow N_2^+ + e$	+15.51	(*22*)
14.	$CO_2 \longrightarrow CO_2^+ + e$	+14.4	(*22*)
15.	$CO_2 \longrightarrow CO + O^+ + e$	+19.1	(*22*)
16.	$CO_2 \longrightarrow CO^+ + O + e$	+19.6	(*22*)
	Exothermic Thermal Reactions		
17.	$OH + O \longrightarrow O_2 + H$	−0.69	(*2*)
18.	$OH + OH \longrightarrow H_2O + O$	−0.61	(*2*)
19.	$OH + OH \longrightarrow H_2 + O_2$	−0.69	(*20*)
20.	$N\ (^2D^o) + H_2O \longrightarrow NH + OH$	−0.7	
21.	$N + H_2O \longrightarrow NO + H_2$	−0.31	
22.	$N + OH \longrightarrow NO + H$	−0.95	
23.	$N\ (^2D^o) + OH \longrightarrow NH + O$	−1.43	
24.	$N\ (^2D^o) + CO_2 \longrightarrow NO + CO$	−2.2	
25.	$N + O_2 \longrightarrow NO + O$	−0.21	
26.	$N + NH \longrightarrow N_2 + H$	−3.98	
27.	$C + H_2O \longrightarrow CO + H_2$	−4.16	
28.	$CO + H_2O \longrightarrow CO_2 + H_2$	−0.52	
	Exothermic Thermal Reactions Requiring a Third Body (Possibly N_2)		
29.	$O + O_2 \longrightarrow O_3$	−1.03	(*22*)
30.	$O + H \longrightarrow OH$	−4.34	(*8*)
31.	$OH + OH \longrightarrow H_2O_2$	−2.2	(*27*)
32.	$N + N \longrightarrow N_2$	−7.38	(*13*)
33.	$N + O \longrightarrow NO$	−5.29	(*13*)
34.	$N + H \longrightarrow NH$	−3.4	(*13*)
35.	$N + C \longrightarrow CN$	−5.96	(*13*)
36.	$C + H \longrightarrow CH$	−3.47	(*13*)
	(Also the reverse of reactions 1, 3, 5 and 6)		
	Exothermic Ionic Processes		
37.	$O_2^+ + e \longrightarrow O + O$	−7.11	
38.	$N_2^+ + e \longrightarrow N + N$	−8.12	
39.	$H_2O^+ + e \longrightarrow H + OH$	−7.6	
40.	$OH^+ + e \longrightarrow H + O$	−9.0	

* All atoms and molecules listed are gaseous and in their ground states unless otherwise indicated. All atoms and molecules are composed of the most common isotope (slight differences will exist if hydrogen, H^1, is replaced by deuterium, for example).

perature of 1,000° K, the ionosphere will lose all of its hydrogen in five years; if the hydrogen exists as atomic rather than molecular hydrogen, the time of escape is reduced from five years to two days. For every two atoms of hydrogen lost, the atmosphere will show a net increase of one oxygen atom gained.

It will be noted that reactions 17, 18, and 19 are all bimolecular and give rise to two products, and thus do not require a "wall" or a third body for conservation of momentum; in other words, they are homogeneous reactions. However, reactions 18 and 19 can probably be ruled out as being of minor importance because the relative amount of water present is smaller than that of oxygen. As a consequence, the partial pressure of OH will be smaller than that of atomic oxygen, and the probability of a collision between OH and O will be greater than the probability of a collision between two OH radicals. Dobson, Brewer, and Cwilong (*4*), who have made careful measurements of the frost point in the stratosphere up to heights of about 10 km, point out that the humidity content of the stratosphere, which drops off rapidly when the stratosphere is reached, is less than expected. The water content of the upper stratosphere and ionosphere is unknown. Elvey (*9*) states, however, that the spectrum of the nonpolar aurora (light of the night sky) demonstrates in the upper atmosphere the presence of water molecules in certain excited states along with oxygen, and sodium atoms, N_2, NO, and O_2 molecules.

For hydrogen atoms or molecules to have velocities equal to the escape velocity as calculated by Jeans (*14*) their velocities must be equivalent to temperatures of several thousands of degrees (at 1,500° K the fraction of hydrogen molecules, assuming a Maxwellian distribution, which have velocities equal to or greater than the escape velocity, is 0.00032, (*23*). Is there any mechanism by which hydrogen atoms or molecules can acquire such high energies? In reaction 17 which we favor as the oxygen-producing reaction, the energy liberated is 0.69 ev; if this excess energy is dissipated as translational energy the fraction 32/33, or 0.67 ev, will be carried by the hydrogen atom. This is equivalent to a "temperature" of about 5,000° K. Such a "hot" molecule will soon reach thermal equilibrium by collisions with the gases at the level of the stratosphere at which it is formed because the molecular mean free path is negligible in comparison to stratospheric distances at the pressures of 10^{-3} to 10^{-5} mm Hg existing in the stratosphere. As greater heights are reached, the pressure drops and the temperature rises. Thus, at a height of 285 km Godfrey and Price (*11*) estimate the temperature to be 1,350° K and the pressure, 6×10^{-8} mm Hg. At this temperature the hydrogen would be rapidly lost as mentioned above. At the present time the rate of vertical mixing between layers of the stratosphere and the ionosphere is unknown, hence it is impossible to estimate the rate at which the hydrogen escapes from the stratosphere. Certainly there is a negligible abundance of hydrogen in the upper atmosphere, in contrast to earlier ideas. Wildt (*30*) points out that only about 1 per cent of the helium formed by radioactive decay in the earth's sedimentary rocks is present in our atmosphere; the rest "must have escaped from the atmosphere during geological time." Hydrogen presumably would escape even more rapidly than helium.

In addition to reactions 3 and 17 as a source of oxygen, the following series of reactions could conceivably result in the presence of free atmospheric oxygen:

$$CO_2 + h\nu \rightarrow CO + O \qquad +5.5\ \text{ev} \quad (23)$$
$$CO + h\nu \rightarrow C + O \qquad +9.14\ \text{ev} \quad (18)$$
$$N(^2D^\circ) + H_2O \rightarrow NH + OH \qquad -0.7\ \text{ev} \quad (11)$$
$$N(^2D^\circ) + OH \rightarrow NH + O \qquad -1.43\ \text{ev} \quad (5)$$

These reactions do not require atomic oxygen for the production of O_2 as does reaction 17. Although Dhar (*3*) states that formaldehyde has been found in rain water, reactions producing it have not been listed in Table 1 because formaldehyde is rapidly decomposed photochemically, particularly in the presence of oxygen (*17*). Table 1, however, does contain an amazingly long list of reactions and demonstrates the richness of the chemical processes in the upper atmosphere. The energy for the ionization of molecules can be thought of as coming from cosmic rays; evidence for ionization is, of course, the free electron and ion content of the ionosphere.

So much for the past history of the origin of oxygen, as far as we can infer it from modern knowledge. What about the present oxygen of our atmosphere, does it have a history? The universally accepted belief is that all of the oxygen of the atmosphere has been produced by the photosynthesis process in land and marine plants, mostly from photosynthesis in the oceans of the world. There is one small difficulty with this theory—the isotopic composition of atmospheric oxygen is not that of oxygen in the water of the oceans as discovered by the author (*5*). Ruben, Randall, Kamen, and Hyde (*21*) demonstrated that the oxygen produced by photosynthesis came entirely from the water and not from the carbon dioxide of the culture medium, while Dole and Jenks (*6*) showed that the photosynthetic oxygen had the expected isotopic composition for isotopic exchange equilibrium between oxygen and water, a composition which is definitely lower in O^{18} content than that of atmospheric oxygen. The present oxygen of the atmosphere must have an origin different from photosynthetic oxygen or the photosynthetic oxygen must have changed its composition by isotopic exchange after being produced photosynthetically. Before we give up the century-old belief in the importance of the photosynthetic origin of oxygen, let us investigate the possibility of O^{18} enrichment of atmospheric oxygen by isotopic exchange.

There are two possible exchange reactions which could enhance the O^{18} content of atmospheric oxygen; the first,

$$2H_2O^{18}(g) + O_2^{16}(g) \rightleftarrows 2H_2O^{16}(g) + O_2^{18}(g),$$

and the second,

$$2H_2O^{18}(g) + CO_2^{16}(g) \rightleftarrows CO_2^{18}(g) + 2H_2O^{16}(g),$$

followed by the irreversible reaction

$$CO_2^{18}(g) + O_2^{16}(g) \rightarrow CO_2^{16}(g) + O_2^{18}(g)$$

Urey (*25*) has recently recalculated, at 0° C and above, the equilibrium constants of these reactions first published by Urey and Greiff (*28*). Values for the fractionation factor, which is the ratio of O^{18} to O^{16} in the oxygen or carbon dioxide divided by the similar ratio for the water in the two equilibria at different temperatures, are shown in Table 2 for the oxygen-water and oxygen-carbon dioxide equilibria. We have extended Urey's calculations to $-50°$ C in the case of the oxygen-water vapor equilibrium.

TABLE 2

FRACTIONATION FACTORS FOR THE WATER-OXYGEN AND WATER-CARBON DIOXIDE ISOTOPIC EXCHANGE EQUILIBRIA

Reaction	223°K	273.1°K	298.1°K
Water vapor-oxygen	1.030	1.017	1.014
Water vapor-carbon dioxide ..		1.055	1.047
Liquid water-oxygen		1.006	1.006
Liquid water-carbon dioxide ..		1.044	1.039

Note that the fractionation factors for the oxygen-water equilibria are much smaller than those for the carbon dioxide-water equilibria and have a practically zero temperature coefficient in the case of the equilibrium between oxygen gas and liquid water. Letting α represent the fractionation factor, the percentage increase in the O^{18} abundance of the oxygen when brought into equilibrium with liquid water (assuming that both the free oxygen and the oxygen in water had the same isotopic composition before being brought into isotopic exchange equilibrium with each other and assuming an infinite volume of water) is $100\ (\alpha - 1) = 0.6\%$ or 6 parts per mil at 273° K. Atmospheric oxygen has an O^{18} content 30 parts per mil greater than the oxygen of Lake Michigan water. Even assuming that the exchange equilibrium is established at 221° K and that the water vapor participating in the equilibrium at this low temperature eventually established an equilibrium with ocean water at 10° C so that the over-all process can be written

$$O_2^{16}\ (\text{stratosphere at } -50°\text{ C}) + 2H_2O^{18}\ (\text{ocean at } 10°\text{ C}) \rightleftarrows O_2^{18}\ (\text{stratosphere at } -50°\text{ C}) + 2H_2O^{16}\ (\text{ocean at } 10°\text{ C}),$$

the O^{18} content of free oxygen will be enhanced 20 parts per mil with reference to ocean water or 25 parts per mil with respect to Lake Michigan water, still less than 30 parts per mil.

Dole and Roake (*7*) have shown, furthermore, that oxygen isotopes do not exchange between oxygen gas and water vapor when passed through a glow discharge at low temperatures and pressures. An exchange of oxygen isotopes could be demonstrated, however, between carbon dioxide and oxygen, so that the enhanced O^{18} content of the atmosphere can be fully and quantitatively explained by the following sequence of reactions:

$$CO_2\ (\text{air}) + H_2O\ (\text{vapor at } 0°\text{ C}) \rightarrow CO_2\ (\text{air}) \text{ of } O^{18} \text{ content equal to 49 parts per mil (Lake Michigan standard).}$$

This CO_2, having an O^{18} content enhanced to 44 parts per mil with respect to ocean water, then undergoes an irreversible and random exchange of its oxygen isotopes with the oxygen of the stratosphere by virtue of reactions 1, 3, 5, 6, 17, and 19 of Table 1 or their reverse, producing in the stratosphere an O^{18} content enhanced to the maximum extent of 44 parts per mil with respect to ocean water. The observed value is 30 parts per mil with respect to Lake Michigan water or 25 parts per mil, to ocean water (*26*). The assumptions in this calculation are: (1) the irreversibility of the photochemically produced exchange of isotopes and (2) the temperature at which equilibrium between the CO_2 and H_2O is established.

Despite this success in accounting for the O^{18} content of the atmosphere by assuming a stratospheric irreversible exchange of O^{18} between O_2 and CO_2, there is still the problem of demonstrating a transfer of the O^{18} enhanced oxygen from the stratosphere to the troposphere. As Dobson, Brewer, and Cwilong have pointed out (*4*), a "general world circulation between the equator and the poles which causes the air in the stratosphere to rise slowly near the equator and to subside slowly near the poles" has been postulated to explain differences in temperature in the stratosphere at low and high altitudes. These authors find it unnecessary to invoke this hypothesis, preferring to base the temperature differences on the differences in radiation due to different ozone content. Thus there seems to be no proof at the present time of vertical mixing between the low and high levels of the atmosphere, although horizontal winds of high velocity are known to exist in the stratosphere. It would be extremely interesting to investigate the isotopic composition of oxygen in the stratosphere as well as from various geographical locations such as the arctic and the tropics. It might be possible to follow large-scale air currents in this way because, from all we know now, the photosynthesis reaction of the oceans is delivering to the atmosphere oxygen having a different isotopic composition from that already present. Similarly, the stratospheric oxygen may have an isotopic composition different from the oxygen in contact with the tropical oceans. The maximum expected difference between stratospheric and photosynthetic oxygen is 33 parts per mil of which the error of measurement is estimated as 1 part per mil.

We come finally to the thought that if oxygen exchange in the stratosphere is significant, then synthesis of oxygen in the stratosphere may also be significant, and that the total abundance of free oxygen in the atmosphere may be slowly increasing. In other words, it would appear that oxygen has a future as well as a past and present history.

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(For references see column 2, p. 96.)

On the Origin of the Chemical Elements

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IN RECENT YEARS MANY ATTEMPTS have been made to explain the observed abundance of the chemical elements and their isotopes. A survey of papers on this subject will be presented in a forthcoming paper (*4*). In this article, an attempt will be made to connect these theories with the general cosmogony developed by von Weizsäcker (*9*), not by offering a complete and quantitative theory, but rather by sketching a possible way of combining ideas expressed by other authors into a theory which may, perhaps, be more satisfactory than the existing ones.[2] The limitations of earlier theories are considered in the survey paper (*4*) mentioned earlier.

The idea is to eliminate one of von Weizsäcker's initial conditions, on the one hand, and to suggest possible initial steps for the theories of van Albada (*1*), Beskow and Treffenberg (*2*), and Mayer and Teller (*7*). In von Weizsäcker's cosmogony the universe is, at the beginning of the present epoch, filled with a turbulent gas. The origin of this gas and its turbulence is assumed to be a problem lying outside the scope of this cosmogony. Von Weizsäcker further assumes, however, that the composition of this gas is the same as the present composition of interstellar gas, or stellar material. It may be sufficient, however, to assume this gas to consist of hydrogen only, thus simplifying the initial conditions of von Weizsäcker's cosmogony. Expressed differently, the solution of the problem of the origin of the chemical elements, other than hydrogen, is thus brought into the present epoch. By the "present epoch," we shall understand the period often referred to as the age of the universe. Following present ideas about the age of the universe, we shall put it at between 10^9 and 10^{10} years (*3, 4, 8*).

As was shown by von Weizsäcker, in the gas filling the universe, concentrations of mass and finally gaseous bodies with masses of the order of stellar masses will be formed. Due to the conservation of angular momentum, these bodies will be rotating fast. In the beginning the energy of these stars will be provided by gravitational energy, and later the deuterium reaction ($H + H \rightarrow D$) will set in. When the densities and central temperatures have become greater, the von Weizsäcker-Bethe carbon-nitrogen cycle will start. (The necessary carbon nuclei will have been formed by nuclear reactions in the way, for instance, discussed by Bethe.) When all the hydrogen has been used, the star will collapse. The development described by Hoyle (*5*) will follow. Of particular interest are those stars which have not yet lost their rotation when their hydrogen is used up. At the interior of these stars heavy nuclei will be formed in a thermodynamical equilibrium. The most reliable analysis of the composition of the interior of such a star can probably be found in Beskow and Treffenberg's paper (*2*). The breakup of the star probably will be rapid, as has been emphasized by van Albada (*1*) and Hoyle (*5*), and in this way the heavy nuclei will be distributed over space.

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[1] The author would like to express his thanks to Drs. Mayer and Teller for a discussion of the subject matter of their paper (*7*) and an opportunity to see the manuscript prior to publication. The material was presented at the Solvay Congress in 1948 and, for publication, will be extended to include a short survey of the older theories. The author is also grateful to Dr. von Weizsäcker for the opportunity to read his paper (*10*) prior to publication.

[2] Some of the ideas presented in this paper are similar to ideas expressed by van Albada and Hoyle.

These heavy nuclei will not, however, be the nuclei found now. As was stressed by van Albada (*1*), the ratio of protons to neutrons will be much lower for these nuclei than for stable nuclei found in nature. Radioactive processes will reduce these nuclei to stable nuclei. Mayer and Teller (*7*) have shown that these radioactive processes will lead to isotopic abundances in qualitative agreement with those observed. In this way, the final result of the processes described here would be a universe filled with chemical elements with about the right isotopic abundances. The advantage of the present theory over that of Mayer and Teller is that we are able to account for the neutron-rich heavy nuclei in a natural way, while Mayer and Teller have to introduce their "polyneutron," the origin of which remains an open question. Also, the present theory has the advantage of considering the total amount of elements in the universe, instead of only single concentrations of matter with masses of the order of stellar masses, as was done by previous authors.

Up to now, the picture given in the present paper has been purely qualitative. Let us try to indicate how it can be changed into a more quantitative theory. It will be shown, especially, that there is no reason as yet not to accept this solution, since it gives satisfactorily the ratio between the abundances of hydrogen and heavy elements. Expressed differently, the processes indicated here are probably sufficiently frequent to account for the present distribution of elements.

It is still impossible to use hydrodynamical arguments to predict the distribution function, $f(M)$, of stars over the various masses. It is possible, however, to use for this function the observational data of Kuiper (*6*). On the other hand, it is well known that stars with masses larger than the sun, which belong to an earlier spectral class, cannot have lived during the whole of the present epoch. Thus, whereas dG-stars, which are observed now, can have been formed at any moment during the last 10^{10} years, B-stars must have been formed in the last 10^8 to 10^9 years (*8*). B-stars which were formed earlier have long ago burned their energy and exploded. These stars (O, B, perhaps A) must, therefore, have been responsible for the presence of heavy elements. According to Kuiper's figures, these stars are, at most, 1 per cent of the total number of stars. However, due to their large masses, they may possess as much as 5 per cent of the total mass of the stars.

If we wish to estimate how large a percentage of the mass of the universe has been involved in the processes leading to the formation of heavy elements, we have to take into account three factors: (a) the present percentage of early-type stars is artificially lowered by their short life; (b) only part of these stars will give birth to heavy elements; the explosion may occur before the central density is sufficiently high; and (c) about one half of the mass of the universe is not stellar, but interstellar material. Taking these factors into account we might safely conclude that at least 1 per cent of the total mass of the universe must have undergone the processes described above.

If we now compare the abundances found by Beskow and Treffenberg (*2*) with the observed abundances, it is seen immediately that with 1 per cent of the mass of the universe giving rise to heavy elements, the formation of heavy elements has been sufficiently frequent to explain their abundances. The high abundance of helium can possibly be explained either by the α-radioactivity of the very heavy elements or by an evaporation from "normal" stars, where helium is continuously formed. The fact that the observed abundances of light elements (C, N, O) are so much higher than in Beskow and Treffenberg's theory may well be due to the possibility that many stars may have been broken up before the formation of heavy elements started (cf. Hoyle, *5*, and van Albada, *1*).

If a quantitative law for the distribution function $f(M)$ and also for the relation between angular momentum and mass of a star was known, it would be possible to calculate more quantitatively both how large a fraction of the mass of the universe had been involved in the various processes and how large a fraction of the O-, B-, and A-stars were broken up before attaining high central densities. It is satisfactory that preliminary considerations by von Weizsäcker (*10*) show that the observed correlation between spectral type and rotation, which points to a possible early rotational instability of O-, B-, and A-stars, can be understood, at least qualitatively.

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TECHNICAL PAPERS

The Influence of Thyroid and Thiouracil on Mice Exposed to Roentgen Radiation

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Although reports are not entirely in agreement, there is considerable evidence that heat sensitizes neoplastic tissue to high-energy electromagnetic irradiation (*1*, *3*, *6*). It has been postulated that temperature effects are, at least in part, referable to effects on cellular metabolism, but few studies have been reported in which metabolic rate was varied independently. The present experiments were made to determine whether or not thyroid or thiouracil feeding would alter the incidence of death among mice exposed to severely damaging whole body radiation.

Mice were of the N.I.H. strain, the first shipment consisting of 70 males about 10 weeks old, the second of 59 males and 61 females about 6 weeks old. They were divided into 3 comparable treatment groups as shown in Table 1. One group was maintained on the stock diet of powdered Purina dog chow. Desiccated thyroid was added to the stock diet for the older mice in the second group, beginning 13 days prior to irradiation (0.5% for 9 days and 0.3% thereafter), and to that of the younger mice, beginning 8 days prior to irradiation (0.5% for 5 days and 0.3% thereafter). In the third group the older mice received 0.5% thiouracil with the stock diet, beginning 13 days prior to irradiation; the younger mice, 0.5% thiouracil beginning 8 days prior to irradiation.

Irradiation was administered at the National Cancer Institute. Peak voltage of the machine was 186 kv; effective voltage, 170 kv; current, 20 ma; added filtration, 0.55 mm of aluminum and 0.25 mm of copper; and focal distance 50 cm. Eight or 9 mice, drawn at random in approximately equal numbers from the three diet groups, were irradiated simultaneously. The mice were under observation for 4 weeks following irradiation.

Evidence that the thyroid of the diet strongly affected metabolic rate is adduced from the fact that when 8 mice from each diet group of the first shipment were subjected to a 24-hour fast in preparation for the determination of oxygen consumption, 4 of those on 0.5% thyroid died, while none of those on the control diet or on thiouracil died. As a result of this experience, we reduced the thyroid content of the diet to 0.3%.

A few determinations of oxygen consumption were made after the mice had been on the experimental diets for about a week and before they were irradiated. The method described by Tabor and Rosenthal (*4*) was used, except that each determination was made with 2 or 4 mice in the chamber, and the lowest value of 2 to 6 determinations of 5-min duration at 22° C was used for each group. The average for 8 mice receiving thyroid was 40% higher than that for mice on the control diet, while the average for 6 mice on thiouracil was 6% higher than the control value. A more extensive study of the oxygen consumption of thyroid-fed mice before and after irradiation is in progress.

The incidence of death following irradiation is shown in Table 1. The difference between the 54.8 mortality of the thyroid group and the 15.6% mortality of the control group is highly significant as shown by chi-square. The difference between the 9.4% mortality of the thiouracil group and the mortality of the control group is not statistically significant.

TABLE 1

THE INFLUENCE OF THYROID AND THIOURACIL ON THE INCIDENCE OF DEATH

Shipment no.	Desiccated thyroid		Control diet		Thiouracil	
	Dead	Alive	Dead	Alive	Dead	Alive
1 (♂)	13	8	5	19	4	21
2 (♂)	12	9	3	16	2	17
2 (♀)	9	11	2	19	0	20
%	54.8		15.6		9.4	

It is of additional significance that 20 of the mice receiving thyroid had died by the 10th day following irradiation, while at that time only 3 of those on the control diet had died. Among the younger mice (shipment 2), 6 died between the 3rd and 5th days, while the first death among those on the control diet occurred on the 5th day, and no others on the control diet died until the 10th day. All of the deaths in the thiouracil group occurred after the 10th day following irradiation.

By use of an oral clinical thermometer with the bulb completely inserted into the rectum, temperatures were determined on 6 mice of each diet group at the end of the 4 weeks of observation following irradiation. Temperatures of the thyroid group averaged 38.5° C (range, 38.2°–39.1°), of the control group, 37.6° (range, 37.4°–37.8°), and of the thiouracil group, 37.2° (range 37.0°–37.6°).

Thyroid feeding resulted in a relatively small increase in rectal temperature, while, without doubt, the metabolic rate was considerably elevated. In preliminary experiments the mortality of irradiated mice, kept in an environment of 10° C, was significantly higher than that of mice at 29° C. At 10°C the rectal temperature is reduced by only about 1 degree from its value in an environment of 29° (*5*), while according to Herrington (*2*), total heat production is approximately doubled at the lower temperature.

It seems probable that metabolic activity, rather than body temperature, is the predominant factor in increasing the mortality of mice exposed to severely damaging Roentgen radiation. Further experiments concerned with these relationships are in progress.

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A Method for Studying Growth in Different Groups of Arthropods

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Linear growth in arthropods is largely discontinuous and usually, but not always, most conspicuous during the molting interval (*1, 5*). Shafer (*9*) likens the linear-growth curve to a series of steps. Size increments during the successive molts are subject to pronounced variation depending, in many instances, on the food supply and on the temperature factor. Also, the final size attained following a particular molt is a function of the initial size, *i.e.* the dimensions prior to molting. Hence, the effect of variation in respect to a particular molt is likely to be cumulative to different degrees in succeeding molts. Wesenberg-Lund (*10*) refers to the rearing method and the method of population analysis for studying age and size of insects at particular instars. MacKay and Weymouth (*4*) in their classical study of *Cancer magister* Dana used population data, largely, for their estimates of per cent increase in size, number of instars, age at sexual maturity, and maximum age.

Animals that grow by molting comprise such a large group that no one method is likely to apply reasonably well to all of them. Rather it is expected that a combination of two or more methods may be needed in the study of even one restricted systematic group. From our studies of the blue crab, *Callinectes sapidus* Rathbun, a method has evolved for estimating the number of postlarval molts typical of a species, and also the size characteristics of the different instars (*2, 3, 6,* and *7*). Because of the application of this procedure to other arthropod groups and its potential value as a tool in attacking diverse practical, as well as theoretical, growth problems, the essentials of the method are related here. The technic was made possible by the large numbers of crab measurements made by Miss Ellen H. Gray and the ingenious rearing experiments carried out by Mrs. Mildred D. Sandoz while working with the writer at the Chesapeake Biological Laboratory and the Virginia Fisheries Laboratory.

The immediate antecedent of these observations was the work of Robertson (*8*) who, by great patience and effort, was able to rear postlarval crabs of this species to an advanced stage in development. Cognizance of the difficulties involved and the obvious variability in the results discouraged similar attempts by us to solve the problem of rearing blue crabs through to the last instar. Even if it were possible to do so, individual variation is so great that a prohibitive, and doubtless impossible, number of crabs would need to be reared in order to yield reliable size averages, representative of the species. The procedure outlined below proved to be reasonably satisfactory and is, seemingly, subject to wide application in the arthropod group.

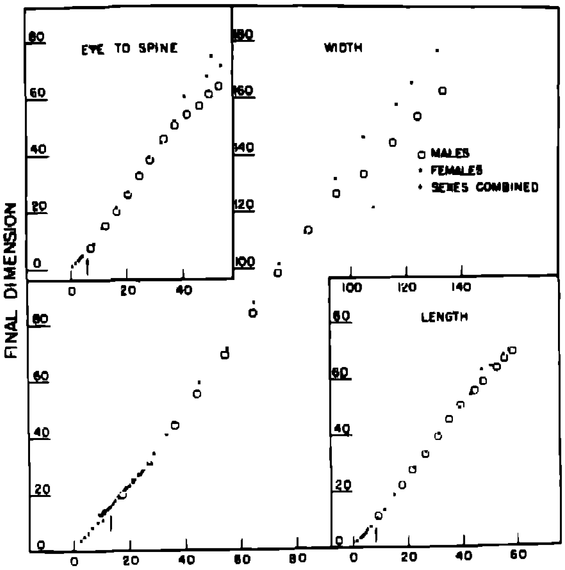

FIG. 1. Relation of initial to final size in *Callinectes sapidus* Rathbun. Sexes are combined in groups to the left of the arrows and in the plus groups.

Small crabs caught just prior to molting were kept in running salt water in the laboratory until they molted. Large crabs molted successfully in specially constructed floats kept near the shore. Hence, simulation of essentially normal conditions was accomplished. Reasonably large numbers of crabs of all sizes were measured before (initial dimension) and after (final dimension) molting. From these data a curve was constructed indicating, for example, the final width, corresponding to any initial width (Fig. 1). This growth curve proved to be a very valuable tool, because once the width of the first instar is known, we have a starting point for using the curve to estimate the theoretical number of instars characteristic of the species. Mrs. Sandoz established the mean width of the first postlarval instar to be 2.5 mm. Thus, from the chart we learn that a crab having an initial width of 2.5 mm has a final width of 3.7 after molting. But this final dimension now becomes the initial width of the second instar which, according to the curve, reaches a final width, on molting, of 5.1 mm and it, in turn, again becomes a new initial width. Continuing in this manner, it has been possible to estimate the number of postlarval molts and the width of each instar, of which there are believed to be 19 or 20 in males and 18, or possibly 19, in female blue crabs (*7*). A mathematical equation was fitted to the molting curve for males and females so that from any initial width one can calculate directly the final width after molting. Hence, knowing the width of the first postlarval instar, it was possible to calculate the widths of the remaining instars.

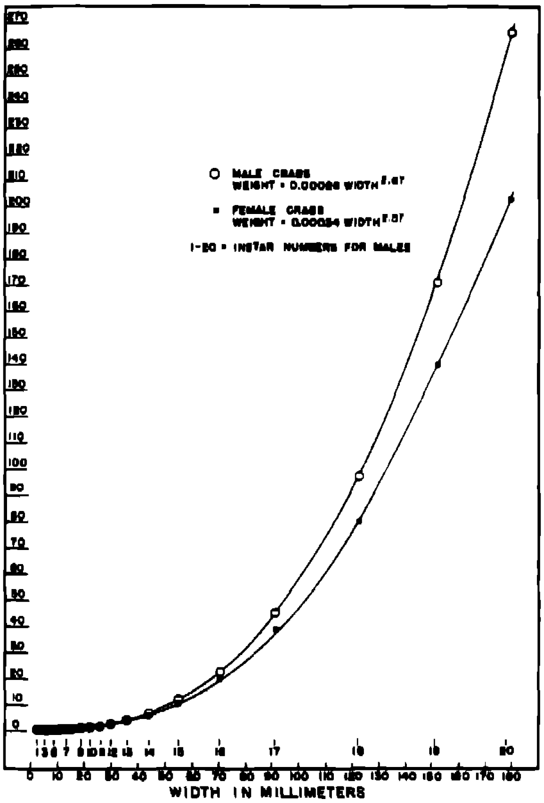

FIG. 2. Showing growth trends in *Callinectes sapidus* Rathbun, based upon growth curve of Fig. 1.

To complete the story, it was necessary to establish the relationship between the width dimension, selected for a basic index of size, and other linear and also weight measurements. The allometry equation $Y = aX^b$, was found to constitute a satisfactory expression of the different linear and also weight relationships. Consequently, from a width measurement, any of the corresponding linear and weight dimensions can be readily ascertained. Since the width of each instar has been determined, it is now possible to calculate the remaining linear dimensions and the weights of each instar (Fig. 2).

The information provided by this procedure makes it possible to analyze certain characteristics of the growth of body parts in relation to one another and to the whole body. Also, a basis is provided for interpreting the effect of environmental conditions and mechanical injury on the normal growth curve as established by the preceding technics. The method has potential use for comparing differential growth rates in geographic varieties as well as closely related species.

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Cultivation of the Lansing Strain of Poliomyelitis Virus in Cultures of Various Human Embryonic Tissues[1]

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An extraneural site for the multiplication of the virus of poliomyelitis has been considered by a number of investigators (*2, 5*). The evidence that this may occur is almost entirely indirect, although recent data indicate that Theiler's mouse encephalomyelitis virus as well as various mouse pathogenic poliomyelitis-like viruses of uncertain origin may multiply in nonnervous tissue (*1, 3*). Direct attempts by Sabin and Olitsky (*4*) to demonstrate *in vitro* multiplication of a monkey-adapted strain of poliomyelitis virus (MV strain) in cultures composed of certain nonnervous tissues failed. They obtained, however, an increase in the agent in fragments of human embryonic brain.

The general recognition that the virus may be present in the intestinal tract of patients with poliomyelitis and of persons in contact with them emphasizes the desirability of further investigation of the possibility of extraneural multiplication. Accordingly, experiments with tissue cultures were undertaken to determine whether the Lansing strain of poliomyelitis virus could be propagated in three types of human embryonic tissues. The results are summarized here in a preliminary manner.

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[1] Aided by a grant from the National Foundation for Infantile Paralysis, Inc.

[2] Post doctorate Fellow of the U. S. Public Health Service.

[3] Senior Fellow in Virus Diseases of the National Research Council.

The technique was essentially the same as that recently described for the cultivation of mumps virus (6). The cultures consisted of tissue fragments suspended in 3 cc of a mixture of balanced salt solution (3 parts) and ox serum ultrafiltrate (1 part). Tissues from embryos of 2½ to 4½ months as well as from a premature infant of 7 months' gestation were used. These were: the tissues of the arms and legs (without the large bones), the intestine, and the brain. Each set of cultures included 4 or more inoculated with virus, and usually a similar number of uninoculated controls. The primary inoculum consisted of 0.1 cc of a suspension of mouse brain infected with the Lansing strain of poliomyelitis virus.[4] The identity of the virus was verified by (a) the character of the disease it produced in white mice following intracerebral inoculation; and (b) its neutralization by specific antiserum.[5] Subcultures were inoculated with 0.1 cc of pooled *centrifuged* supernatant fluids removed from the previous set of cultures.

The procedure of cultivation differed from that usually followed by other workers in that the nutrient fluid was removed as completely as possible and replaced at periods ranging from 4 to 7 days. Subcultures to fresh tissue were prepared at relatively infrequent intervals, ranging from 8 to 20 days.

Two experiments have been carried out employing cultures composed chiefly of skin, muscle and connective tissue from the arms and legs. The findings in each have been essentially the same. In the first, a series of cultures has now been maintained for 67 days. During this interval, in addition to the original set, three successive subcultures have been made to fresh tissue and the fluids have been removed and replaced 10 times (Table 1). Assuming that at each change of fluid a dilution of approximately 1: 15 was effected and that at the initiation of each set of cultures the inoculum was diluted 30 times, it has been calculated that the 10% suspension of infected mouse brain used as the primary inoculum had been diluted approximately 10^{17} times in the fluids removed from the third subculture on the 16th day of cultivation. These fluids, however, on inoculation into mice and monkeys, produced typical paralysis. Accordingly, since the mouse LD_{50} of the original inoculum was 10^{-3}, it would appear that the increase in virus during the course of the experiment was at least of the order of 10^{15} times. During the 67-day period of cultivation a progressive decrease in mouse infectivity was recorded (Table 1). On the other hand, in the second experiment, mentioned above, the calculated increase in virus during a 52-day period is now of the order of 10^{16} times and no decrease in mouse infectivity has so far been observed.

The agent propagated in the first experiment continued to exhibit the principal characteristics of the Lansing strain during the period of cultivation, as indicated by the following observations: (a) fluids from each set of cultures produced paralysis and death in mice after intracerebral inoculation; (b) the agent present in the fluids of the second set of subcultures was neutralized by antiserum specific for the Lansing strain; (c) following intracerebral inoculation, the fluids from the third set of subcultures produced flaccid paralysis within 7 and 10 days, respectively, in two rhesus monkeys. Microscopic examination of the spinal cords of these animals revealed lesions characteristic of poliomyelitis.

TABLE 1

MULTIPLICATION OF LANSING POLIOMYELITIS VIRUS IN TISSUES OBTAINED FROM THE EXTREMITIES OF HUMAN EMBRYOS

Culture set	No. of nutrient fluid changes prior to subculture		Day of incubation subculture done		Mouse LD_{50} of pooled fluids used to inoculate subcultures		Calculated dilution of original inoculum at time of subculture	
	Exp. 1	Exp. 2	Exp. 1	Exp. 2	Exp. 1	Exp. 2	Exp. 1	Exp. 2
Original*	3	4	20th	20th	$10^{-3.0}$	$10^{-1.67}$	10^{-5}	$10^{-6.2}$
1st subculture	2	2	19th	12th	$10^{-1.67}$	$10^{-1.71}$	$10^{-8.8}$	$10^{-10.0}$
2nd subculture	2	4	12th	20th	$10^{-0.68}$	$10^{-1.54}$	$10^{-12.6}$	$10^{-16.2}$
3rd subculture	3	..	16th	....	$10^{-0.16}$	.....	$10^{-17.7}$	.....

* The LD_{50} of the suspension of mouse brain used as the inoculum in the first experiment was 10^{-3}; that of the suspension employed in the second experiment was $10^{-1.67}$.

Cultures of intestinal tissue were prepared with fragments from the entire intestine of human embryos, except in one experiment in which jejunum of a premature infant was used. In the latter, the bacteria were eliminated in the majority of cultures by thorough washing of the tissue and by the inclusion in the original nutrient fluid of 100 units/cc of penicillin and of streptomycin.

In one experiment with embryonic intestine, which included two subcultures and 7 changes of nutrient fluid, the calculated dilution of the original inoculum was of the order of $10^{13.7}$ times. On the basis of the mouse LD_{50} of the original inoculum and that of the last supernatant fluid, it was calculated that the virus had increased about $10^{12.7}$ times. The identity of the agent thus cultivated in intestinal tissue has not yet been confirmed by neutralization tests or monkey inoculation, but it elicits a response in the mouse typical of the Lansing virus.

The cultures prepared with intestine of the premature infant have, so far, been maintained 17 days with 3 changes of nutrient fluid. Virus has been demonstrated, by mouse inoculation, in the fluids removed during the course of the experiment, including that of the 17th day. The calculated multiplication of the virus was approximately 10^7 times. This finding suggests that multiplication occurred in this tissue which, from the embryologic point of view, is more mature.

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[4] This strain was isolated by Dr. Charles Armstrong and obtained through the courtesy of Dr. S. D. Kramer.

[5] This serum was obtained through the courtesy of Dr. Isabel Morgan. It was prepared by hyperimmunization of rhesus monkeys with her strain of the Lansing virus.

To compare the increase of virus in nervous tissue with that in tissue of the intestine and the extremities, cultures of embryonic brain were prepared. The multiplication of the virus in this medium has been comparable to that in the other types. Thus in one experiment carried out contemporaneously with the series of embryonic intestinal cultures mentioned above, the calculated multiplication of virus was of the order of 10^{12} times.

No evidence was obtained which indicated that an agent other than the Lansing strain of virus was propagated in any of the three types of tissue. Mouse infectivity tests for the presence of virus in the supernatant fluids of uninoculated control cultures were negative. Aerobic and anaerobic cultures of supernatant fluids yielded no growth of bacteria.

On microscopic examination of fragments of the three types of tissue, removed after about 30 days of cultivation, differences have been observed in cell morphology between those derived from inoculated and uninoculated cultures. Many of the fragments from uninoculated cultures contained cells which appeared to be viable at the time of fixation, as indicated by the normal staining properties of the nuclei and cytoplasm. In contrast, the nuclei of the majority of the cells in fragments from inoculated cultures showed marked loss of staining properties. Since the amount of material which has been studied is as yet relatively small, one cannot conclude that the changes observed in the inoculated cultures were caused by the virus.[*]

It would seem, from the experiments described above, that the multiplication of the Lansing strain of poliomyelitis virus in the tissues derived from arm or leg, since these do not contain intact neurons, has occurred either in peripheral nerve processes or in cells not of nervous origin.

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[*] We are indebted to Dr. Duncan Reid and members of the staff of the Boston Lying-in Hospital for providing the human embryonic tissues and to Dr. Alwin M. Pappenheimer for the preparation and examination of sections of tissue culture material.

Insect Vectors of Phony Peach Disease[1]

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Phony peach is a virus disease of economic importance in the southeastern United States (*1*). While the disease attacks other species of the genus *Prunus*, its most serious effects result from heavy infections in commercial peach orchards, particularly in the South Atlantic and Gulf Coast States from South Carolina to Louisiana. The disease has caused the loss of more than 1,500,000 peach trees during the period from 1929 to 1947, inclusive.

Since 1936 the Bureau of Entomology and Plant Quarantine, in cooperation with the Bureau of Plant Industry, Soils, and Agricultural Engineering, has been conducting research in an effort to find the insect vector, or vectors, of phony peach. Following an extensive survey of insects associated with peach orchards in areas where the annual disease incidence was high, in other areas where few new cases occurred each year, and finally, in areas where there appeared to be no local spread, a test program utilizing the most likely insect suspects was undertaken.

Results of the survey, together with data derived from experimental transmission of the disease, suggested the probability that phony peach was being spread by one or more stem-feeding Cicadellidae (leaf hoppers) belonging to the subfamily Tettigellinae. Although 53 species of insects, including members of several different families of Homoptera and a number of species of Cydnidae (Hemiptera), have been used in transmission tests, most attention for the last four years was given to four species of leaf hoppers.

From 1939 through 1944 the work was conducted at Chattanooga with field-grown peach trees that were unprotected from possible natural infection. During the course of these tests three of the experimental trees developed symptoms of the disease. One had been subjected to inoculation by *Cuerna costalis* (F.), one by *Graphocephala versuta* (Say), and one by *Homalodisca triquetra* (F.),[2] all members of our selected group of suspects. One case of phony peach occurred in one of the many check trees that were maintained.

In 1945 the work was transferred to Fort Valley, Georgia, where it was necessary to grow the experimental trees in a large screened cage because of the certainty of considerable natural spread in unprotected trees. Insects collected on peach trees, weeds, and wild and cultivated shrubs were confined in cheesecloth bags on branches of phony trees. After 4 or 5 days the bags with their contained insects were transferred to test trees growing in the large cage. The bags were left on those test trees for 30 or more days, unless all the insects had died earlier. At the end of the test period the bags were carefully removed in such a manner that none of the insects escaped within the large screened cage. The test trees were Elberta June-buds in their second year from seed. In order to provide fully adequate controls, alternate trees were left as checks. Transmission tests were made from April to October. During the following winter the test trees and checks in the cage were dug and replanted in isolated plots in areas where there were no commercial orchards and where phony disease was rare or unknown.

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[1] The diagnoses on which this report is based were made by Lee M. Hutchins and L. C. Cochran, of the Bureau of Plant Industry, Soils, and Agricultural Engineering, and by L. D. Christenson and William F. Turner, Bureau of Entomology and Plant Quarantine, of the United States Department of Agriculture.

[2] The leaf hoppers actually used in each of these and all other tests were identified by P. W. Oman and J. S. Caldwell, Division of Insect Identification, Bureau of Entomology and Plant Quarantine.

Phony disease has a long incubation period in peach trees, apparently from about 18 months (or two growing seasons) to as much as 3 years. Although a few of the trees used in the 1945 tests showed suspicious symptoms in September 1947, it was not until the spring of 1948 that reliable diagnoses could be made. At that time 7 trees were positively phony, and 8 more were almost certainly so. Of the 7 positive cases, two had been inoculated by *G. versuta*, three by *H. triquetra*, and two by *Oncometopia undata* (F.). All of the 8 trees that were almost certainly diseased had been inoculated with *H. triquetra*. None of the check trees showed any symptoms of the disease.

TABLE 1

Species	Total No.	Phony peach transmissions	
		Definite	Probable
H. triquetra	203	8	8
C. costalis	64	1	2
O. undata	26	3	0
G. versuta	20	2	0

In contrast with the 1945 series, a number of the trees used in the 1946 experiments showed positive symptoms in July 1948. At that time seven definite cases of phony peach were noted. One of these trees had been inoculated by *C. costalis*, one by *O. undata*, and five by *H. triquetra*. At least two other trees inoculated by *C. costalis* are almost certainly diseased. All check trees appeared to be normal.

The totals for definite and probable insect transmissions of phony peach obtained in the test series of 1945 and 1946 are presented in Table 1. One check tree was provided for each test tree, a total of 313 in all. All check trees are still normal.

The definitely positive results represent from 2 to 28% successful transmission by the different species. Although all these insects are general feeders, three species are known to be associated with peach trees at certain seasons. For the fourth one, *C. costalis*, a natural association is doubtful, but the insect survives for periods of a month or more when confined on peach. This species has thus far been the least successful of the four in transmitting the disease. All four species belong to the subfamily Tettigellinae, and it appears quite possible that other members of this group may be able to transmit phony peach even though they may be of no real importance as vectors.

In 455 experiments involving the use of the remaining 49 species of insects that were tested, all results were definitely negative.

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Inhibition of the Adenosinetriphosphatase Activity of Preparations of Myosin[1]

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During the past year we have been investigating the inhibition of the adenosinetriphosphatase activity of the myosin complex by extracts of the posterior pituitary gland. Our interest in this casual observation was due to the finding that the inhibition was greatly reinforced by the addition of acetylcholine. Although a considerable mass of data has been accumulated, truly definitive experiments have not been devised, and it is considered

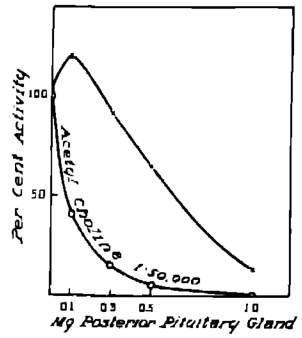

FIG. 1. ATPase activity in the presence of extract of posterior pituitary gland and acetylcholine. The percentages of the control values are plotted. Activity was determined by analysis for inorganic phosphate after 5-min incubation at 30° C in 1 M KCl buffered at pH 9.0 with 0.1 M $NaHCO_3 - Na_2CO_3$. One mg of $CaCl_2$, 10 mg of ATP (sodium salt), and a solution of twice-precipitated myosin (0.2 mg of protein nitrogen) containing 0.001 M NaCN were present in a total volume of 5 ml. Acetylcholine and the soluble material of the desiccated posterior pituitary gland were added as indicated. The incubation was terminated by the addition of trichloroacetic acid to make a final concentration of 5%.

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[1] These studies were supported by a grant from the U. S. Public Health Service.

desirable not to delay further the presentation of our results.

Results, typical of those we have obtained, are illustrated in Figs. 1 and 2. Twice-precipitated myosin from the rat, obtained by a procedure utilizing cyanide (*1*), was used in these experiments. Two methods were necessary in following the ATPase activity. For comparative studies, analysis for inorganic phosphate was sufficient, but, in order to follow rapid changes, manometric methods (*2*) were necessary. It is apparent from Fig. 1 that an extract of the posterior pituitary gland[3] is inhibitory at most concentrations but is capable of activation when used in lower concentrations. If acetylcholine is supplied, the extract of posterior pituitary gland is inhibitory at all significant concentrations; acetylcholine was without effect when added without the extract of the posterior pituitary gland. It is possible that the inhibition with the crude extract of the posterior pituitary gland was due to a significant concentration of acetylcholine in the extracts of the gland. A factor not covered in Fig. 1 concerns the concentration of calcium; maximal inhibition was obtained with maximal activation of the enzyme by calcium ions. When the calcium level was low, little activity was observable, and the inhibition was difficult to demonstrate; when calcium was supplied in great excess, the inhibition was greatly reduced. For example, with 1 mg of $CaCl_2$, only 22% of the control activity (at 5 min) was observed, whereas the comparative value with 5 mg was 51%. In Fig. 2, typical data obtained by manometric methods are represented. It is seen that after a few minutes the inhibition disappeared; after this stage the ATPase activity proceeded at a normal velocity and to the same extent as the control. In studies of this release of inhibition it was found that the release is delayed by anaerobic conditions or by addition of eserine or DFP. In so far as could be determined, the release of inhibition is due to hydrolysis of acetylcholine and/or enzymatic or oxidative destruction of the factor in the extract of the posterior pituitary gland; *i.e.* inhibition was re-established, after release, by the addition of either extra acetylcholine or extra extract of the posterior pituitary gland in the presence of an excess of the other material. It was not possible to predict, within narrow limits, the amount of extract of posterior pituitary gland necessary to establish complete inhibition with different preparations of myosin; concentrations of acetylcholine varying from 1: 10,000 to 1: 100,000 were not found to differ with various preparations of myosin except in so far as the release of inhibition was concerned. Release of inhibition was delayed longer with higher concentrations of acetylcholine. In no case did we fail to obtain inhibition of the activity of myosin from rabbit or rat with the combination of posterior pituitary and acetylcholine.

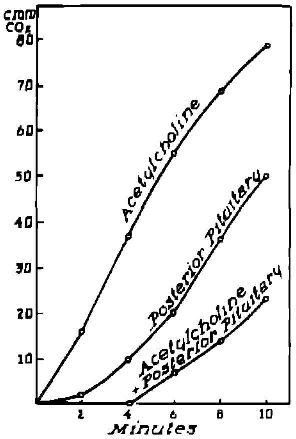

FIG. 2. Manometric measurement of inhibition of ATPase activity of myosin. The incubations were conducted in an atmosphere of nitrogen-carbon dioxide in 1 M KCl buffered with 0.1 M carbonate-bicarbonate. The initial pH (after saturation) was about 8.2; the total volume was 3.5 ml and only half the amount of myosin was used, but, otherwise, the substrates were the same as in Fig. 1. The soluble material from 1 mg of desiccated posterior pituitary gland and acetylcholine in a final concentration of 1 : 30,000 were used as indicated. After 30 min, the CO_2 production was equal in all cases, and the amounts of inorganic phosphate in the digests were identical within the range of error of the methods.

It was found impossible to obtain adequate purified preparations of the known factors of the posterior pituitary gland for comparison, but certain observations have indicated a possible identity of our factor with one or more of the known principles of the posterior pituitary gland. The active material was found to dialyze through Cellophane membranes and to be inactivated by oxidation with bromine water, by treatment with 1 N NaOH for 3 hrs at room temperature, and by hydrolysis for 3 hrs at 94° with 1 N HCl. Activity was also destroyed by incubation of the extract of posterior pituitary gland with an extract of duodenum of the hog. Commercial preparations of "Pitressin" were more active than those of "Pitocin." Nervous tissue (brain of rats) was found to contain similar material, although in an apparently lower concentration than the posterior pituitary gland.

The significance of these results is difficult to assess at this time. If a relaxation mechanism for the transfer of energy to the myosin complex is assumed, the results would be grossly consistent with the known effects of acetylcholine and of the principles of the posterior pituitary gland. Studies of the physical aspects of this phenomenon have been seriously handicapped by the time factors involved, and our results do not allow for a unique interpretation as to whether or not the myosin complex is in the contracted state during the period of inhibition.

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[3] Prepared from desiccated posterior pituitary glands supplied through the courtesy of Dr. Oliver Kamm, of Parke, Davis and Company. One hundred mg of the dried powder was extracted with 10 ml of saline, and the filtrate was used in the experiments reported here. The sodium salt of ATP was obtained through the courtesy of Dr. E. A. Osterberg, of Abbott Laboratories.

Comments and Communications

In Support of Michurin's Biological Theory in Higher Institutions of Learning

[The following editorial, by S. Kaftanov, Minister of Higher Education in the USSR, is published in its entirety from *Izvestia*, September 8, 1948, in the belief that it has high informational value for scientists in America.]

There are two opposite trends in biological science. One of them is progressive, and materialistic, called Michurin's theory in honor of its founder, the great reformer of nature, Ivan Vladimirovich Michurin; the other is the reactionary, idealistic Weismann's or Mendel-Morgan theory. The founders of this theory were, as it is well known, reactionaries in science: Weismann, Mendel, and Morgan.

In opposition to the Mendel-Morgan trend, Russia developed and, encouraged by the Soviet regime, brought to its full bloom, the great theory of the great modifier of nature I. V. Michurin.

Michurin's materialistic theory has been continually enriched by the works of his followers, with the academician T. D. Lysenko at their head. This trend in biology has developed into a mighty current which has taken hold of the masses. It inspires millions of collective farmers with faith in the creative power of their efforts and gives them a firm assurance in the realization of new successes in the field of abundancy of farming products.

The Michurinists have proved, not by word, but by demonstration, that it is possible to direct the inborn qualities of animals and plants and to influence the development of animals and plants in a desired manner. Michurin's theory has adopted and developed the best sides of Darwinism. Darwin had explained the evolution of animals and plants from the materialistic point of view. Michurin has developed this knowledge and taught methods of directing the process of producing new species of plants and new species of domestic animals, thus transforming Darwinism into a really practical, creative doctrine.

Michurin's theory is closely bound to another progressive trend in our science—that of Williams' methods of fertilizing the soil, methods that have adopted and developed the best ideas of the Russian classics in the science of agriculture, those of Dokuchaev, Kostichev, and others.

Thanks to the care of the Bolshevist Party and of the Soviet Government, as well as to the personal care of our great leaders, Lenin and Stalin, Michurin's theory has been preserved from oblivion and has become the property of the people. The efforts of Michurin's followers, led by the academician T. D. Lysenko, have brought it to a new height of achievement. During the last session of the USSR Lenin Academy of Agricultural Sciences, the report of academician T. D. Lysenko concerning the status of biological science, duly supported by the Central Committee of the All-Russian Communist Party, has been made subject of consideration. This session has become an important factor in the strengthening and further expansion of the progressive biological theory of Michurin. This session has brought to light the opponents of Michurin's doctrine in biology and has dealt a stunning blow to the reactionary Weismann-Morgan theories. This session has proved to be the greatest triumph of the victorious Michurin theory.

The task of the future is now to develop and to spread with the utmost persistence the world's most advanced and most progressive biological theory, that of Michurin. The success of this task will depend upon the system of teaching and of research that will be carried on in higher institutions of learning.

Unfortunately, the theories of Weismann, Mendel, and Morgan, born in foreign countries, have found their supporters in the midst of our biologists.

The first and the most outstanding representative of this pseudoscientific trend in our country was the Leningrad professor Filipchenko and the Moscow professors Koltsov and Serebrovsky. They actively professed racist pseudo science—the so-called eugenics.

The first supporters of the Mendel-Morgan theories—Filipchenko, Koltsov, and others—openly disavowed the materialistic basis of Darwinism; their modern followers and supporters have done their utmost to mask and hide their anti-Darwinistic idealistic opinions and have always carried the banner of Darwinism. Amidst these, the academician I. I. Schmalhausen has to be named first.

Academician Schmalhausen denies the inheritance of acquired characters. He finds that evolution depends upon mutations which originate directly in the germ cells of the organism and have a quite accidental and indeterminate character, not regulated by the conditions of its life. This idealistic, reactionary theory is fundamentally antagonistic to Darwin's teaching. Nevertheless, Schmalhausen always hid under the banner of Darwinism.

Weismann's reactionary theory has found many adherents and supporters in numerous biological research institutions, as well as in the Universities of Leningrad and Moscow and, especially, in the Timiriaseff Academy of Agriculture.

Our homemade Weismannists, such as Academician Schmalhausen, Professors Serebrovsky, Zavadovsky, Zhebrak, Dubinin, and others, have fought for years the progressive and revolutionary teaching of Michurin's biology.

The laxity of certain ministers and institutions, of the Minister of Higher Education in particular, has encouraged these people and has given them the opportunity of occupying many responsible positions in universities, institutes, etc. Using these opportunities they strongly opposed the Michurinists, hampered their work, sometimes treated them with contempt, and thus did the greatest harm to Soviet science and national agriculture.

It is in the Moscow and Leningrad Universities that the bearers of this reactionary-idealistic Weismann's "science" had built their mightiest strongholds.

Thanks to the laxity of the president of Moscow University, as well as of that of the Central Administration of the Universities of the Ministry of Higher Education, efforts have been made in the Biological Faculty to organize the anti-Michurinists by means of conferences of anti-Darwinistic character with specially selected participants; the Michurin theory was there and then treated with the highest contempt.

Several chairs of the Biological Faculty of the Leningrad University were also occupied by representatives of formal genetics. Professor Poliansky, vice-president of the University, spoke openly against the Michurin doctrine and its followers. The former vice-president of the Biological Faculty, Docent Lobasheff, actively opposed the appointment of Michurinist biologists.

Many biological chairs at other universities were also occupied by anti-Michurinists—for instance, Professor Poliakov in Kharkov, Professor Gershenson in Kiev, Professor Chetverikov in Gorky. This proves that the Ministry of Higher Education, as well as its Central Administration of Universities, was inefficient in its supervision of biological studies in the universities.

The same is the case in agricultural colleges and even in the most important one, the Timiriaseff Academy of Agriculture—several leading biological chairs have been occupied, up to the present, by anti-Michurinists, for example, the anti-Michurinist Professor Zhebrak held the chair of genetics at the Academy. Many other chairs were also held by formal geneticists, as Professor Borisenko and others. Even the director of the Academy, Professor Nemchinoff, shared the convictions of Weismannists and opposed the appointments of Michurinists.

Nevertheless, it is noteworthy that many biological chairs in agricultural colleges are occupied by worthy representatives of the progressive Michurin theory, who worthily carry on the great work of the famous scientist Ivan V. Michurin. Such are: Professor Yakoleff of the Michurin Fruit and Vegetable Institute, Professor Paguibin of the Tashkent Agricultural Institute, Professor Tikhonoff of the Kazan Agricultural Institute.

In other branches of agrobiological science (agriculture, pedology, cultivation of fruits and vegetables) the majority of the chairs in agricultural colleges are occupied by representatives of the progressive Michurin theory.

Strong defects in the teaching of biology can be traced also in medical colleges. The teaching of biology is based in many of these colleges on textbooks permeated with Mendel-Morgan ideas. Many of the chairs of medical institutes are also occupied by supporters of Mendel and Morgan in biology or by persons who, although not actively opposing the Michurin doctrine, are, nevertheless, basing their convictions and pedagogical activities on the spirit of the Weismann-Mendel-Morgan ideas.

Considerable defects in the teaching of biology exist also in teachers' colleges. The Departments of Teachers' Colleges of the Ministry of Higher Education, and the Ministry of Public Education of the Federation of Republics, have not sufficiently opposed the anti-Michurin trend that tended to keep out the Michurinists.

The Ministries of Higher Education, of Agriculture, of Public Health, and of Public Education have not become aware soon enough of the reactionary character of the anti-Michurinist trend in biology, did not put a stop to the spreading of such reactionary ideas, and did not create a free field for the new generation of Michurin's followers. And there is no doubt that these followers are very numerous.

This has been proved by the session of the Academy of Agriculture when many of the members of the Colleges spoke fervently in favor of Michurin's theory.

We must admit that the principal responsibility for the defects of the teaching of biology lies on the Ministry of Higher Education.

We are first of all responsible for not having used enough propaganda for the development of Michurin's doctrine in biology, for having been blind to the dangerous activities of anti-Michurinists in our higher institutions of learning, and for having admitted them to leading roles in many of them. This is the principal cause of the great defects in our teaching of biology, which was in evidence up to the last session of the Lenin Academy of Agriculture.

The first task of the Ministry of Higher Education must now consist in the elimination of defects in the field of biology teaching and in the clearing of the field for Michurin's doctrine. Curricula and programs, textbooks, and methods of teaching and of research must be reexamined and reorganized as must the entire system of education and training of cadres of scientists and the activities of publishers and of journals. All biological chairs and faculties must be held and supported by qualified Michurinists, capable of developing the progressive Michurin's doctrine.

The success of this reform in the teaching of biology in our colleges will depend most of all upon the right choice of the teaching personnel.

Action along these lines has already been started. The anti-Michurinist Nemchinov, former director of the Timiriaseff Academy of Agriculture, has been replaced by Comrade Stoletov, and Academician Lysenko has taken charge of the chair of genetics and selection; Academician Present has replaced the anti-Michurinist Yudintseff as dean of the biological faculty of the State University of Moscow, etc. Our present aim is to fill the ranks of the teaching personnel by biologists-Michurinists.

Programs of basic courses must be urgently re-examined and modified. Many of these programs in the biological sciences are either entirely based on the Mendel-Morgan theories or considerably affected by the revelations of the reactionary biological "science." The reform of those programs should not be delayed even for a single day. This is one of the most urgent aims.

The textbooks of basic courses in biology are quite unsatisfactory. What has been published up to the present in biology for colleges does not guarantee an education based on the progressive Michurin doctrine.

Publishers specializing in biological literature (such as Selkhozgiz, Medgiz, ''Soviet Science,'' the Academy of Science, Uchpedgiz, etc.) have not been aware of their responsibility when publishing theoretical or popular scientific books and other works on biology for colleges.

An illustration of this state of things is given by the publication of a book written by a member of the Academy of Medical Sciences, S. N. Davidenkov, entitled ''Evolutionary-Genetic Problems in Neuropathology.'' It was published in 1947 with an enthusiastic preface by Academician L. Orbeli. Fully accepting the Mendel-Morgan ''theories,'' the author made an attempt to revise the theory of Engels concerning the humanization of apes under the influence of their working activities.

We must have textbooks based on the progressive Michurin theory.

Schools for higher education will not be able to carry through this reform of teaching in biological sciences if they do not at the same time reconstruct their scientific research work.

Much of this research work, led by partisans of Mendelism-Morganism, had but slight relation to real life dealing with the practice of medicine, agriculture, veterinary science, and animal husbandry. Professor Schmalhausen, for example, holding the chair of Darwinism in the University of Moscow, published volumes of ''works'' dealing with problems that have nothing to do with the practice of Socialist Construction.

At the University of Kharkov, methods were applied to problems of Darwinism and genetics that had nothing to do with practical needs of life. Docentin Mikhailova occupied herself with ''Interspecific Divergence and Crossability in the Genus *Dianthus*.'' Docent Dubovsky had for his objective the elucidation of ''The Cytological Basis of the Early Stages of Divergence in Mosquitoes of Different Species and Subspecies.'' Countless other problems, without any theoretical or practical significance, were likewise pursued, serving sometimes only as evidence for pseudoscientific conceptions in biology.

Detachment from life, limitations of academic outlooks, practical sterility, such are the qualifications of the scientific work produced by all research carried on by supporters of Mendelism-Morganism. It is necessary to make a sharp change in all scientific research done by our colleges and direct it toward the most active collaboration with requirements of practical life, as well as with the interests of our national economy.

The party of Lenin-Stalin protects the progressive Soviet science against infiltration of foreign, reactionary influences. The history of our Bolshevist Party serves as an example of a continuous and strenuous fight for a flourishing, progressive science, a science ''that has the courage to tear down old traditions, rules, forms, when they prove to be outlived, when they become breaks stopping the onward movement, a science that creates new traditions, new forms, new rules'' (Stalin).

The struggle in the field of biology has ended in a complete triumph of Michurin's doctrine, presenting a new stage in the development of materialistic biology.

Thanks to the Bolshevist Party and, personally, to Comrade Stalin, ways for the further triumphant march of the most progressive Michurin biological science are now clear. The scientists of our colleges will apply, from now on, all their energy to the propaganda of Michurin's biology and to the support of undivided rule of Michurin's biological doctrine in our higher institutions of learning.

Instruments for Recording Blood Pressure

In a recent issue of *Science* (October 8, p. 393), David F. Marsh points out that a photoelectric recording microammeter may be used in connection with a strain-gage manometer to record the mean blood pressure of small animals. The models mentioned are entirely satisfactory for the purpose described but are by no means the only instruments of the SCE type which may be used with the manometers.

In addition to the photoelectric microammeters, a number of other recording instruments may be used with good results. Recording potentiometers and resistance thermometer recorders made for industrial use are quite suitable. These types have the proper speed of response to indicate mean pressures and to be insensitive to individual pulses.

Standard models of strain-gage manometers that have a linear frequency range up to 70 cycles/sec are available. Such manometers are adequate for the accurate recording of arterial pulse contours in humans and in larger experimental animals. When used with the Brush amplifier and pen motor it is possible to realize all the advantages of ease in operation of the manometer as well as the advantages of a direct-writing recorder. In addition, accurate measurements of the systolic and diastolic pressures are possible. It is also possible to use these manometers with the string-type electrocardiograph galvanometer.

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Requesting Reprints from Abroad

D. J. Bell, of the University of Cambridge, reports that he has received over 200 requests from U. S. scientists for reprints of one of his articles, of which he was allowed only 50 copies. Believing that many British scientists have been faced with a similar problem, he has asked *Science* to publish the brief reminder that paper is scarce in the United Kingdom and that, for economic reasons, many British scientists do not feel that they can afford to reply to such requests, much as they would like to do so.

In Memoriam

Robert G. Green

1895–1947

Robert Green was a naturalist-turned-doctor in the nearest sense. Loving the out-of-doors and its creatures, he gave his mind to their diseases. The unexplained death of an owl or snowshoe rabbit was enough to start him on a long, purposeful investigation, during which he exploited nature's resources as well as his own. By inoculating horned owls, barred owls, and screech owls, he showed that the dead bird had been victim to an unknown virus; and by watching " snowshoes" month after month in their forest domain he discovered "shock disease," a malady so depleting the blood sugar that the animal, if abruptly frightened, dies at its first leap. When litters of wild foxes, lately whelped, were needed for tests of the fox encephalitis he had discovered, he got the litters as a matter of course. It never entered his reckoning that they might be hard to come by.

There is much for the field naturalist in Green's papers, told because pertinent to his work—for example, his comparison of the habits of the ruffed grouse, snowshoe rabbit, and cottontail, as bearing on their relative infestation with the rabbit ticks which transmit tularemia, and his demonstration that the snowshoe lives its entire life within a quarter-mile of where it is born (a fact disclosed by the banding of thousands of rabbits as part of a study of the rythmical rise and fall in their numbers). Some of his work had immediately practical aspects. An encephalitis was ravaging the silver fox ranches of the Northwest when he revealed its virus cause and devised a vaccine which stopped it. Appealed to again by the ranch owners, because now another strange illness had appeared among their animals, he saw that the spastic paralysis which had developed was like Wernicke's polioencephalitis in man and traced it to a lack of vitamin B_1, as in the human case. The foxes had been kept on frozen fish, and this, he found, contained an agent so potent as to destroy the entire vitamin intake if the diet contained more than 10 per cent of it.

Green always had larger matters in mind. During the period of excited conjecture following crystallization of the tobacco mosaic virus, he put the case for viruses being retrograde organisms in a way which has not been bettered (*Science*, 1935, **82**, 2132). His speculations were often startling, but their outcome made plain repeatedly that they could not be ignored. Through his ponderings on virus and host-cell relationships he was drawn at last to the cancer problem, coming to it with unique views. When the tasks he planned are in time taken up by others, one may hope it will be with something of his own discernment, intensity, and delight.

Green was a shy, warmhearted man whom science emboldened. Patient in act, he was restless in thought, as becomes the discoverer. Jenner and John Hunter would have liked him well.

PEYTON ROUS

The Rockefeller Institute for Medical Research

Robert Tracy Jackson

1861–1948

Robert Tracy Jackson, noted paleontologist and retired Harvard professor, died at his home in Peterborough, New Hampshire, at the age of 87.

He was born July 13, 1861, at Dorchester, Massachusetts. In 1884 he graduated from the Lawrence Scientific School of Harvard with the degree of Bachelor of Science and received his Doctor of Science degree from Harvard in 1889. Three years later he joined the Harvard faculty, where, in 1911, he was named associate in paleontology, and subsequently, Curator of Fossil Echinoderms in the Museum of Comparative Zoölogy.

As a teacher Dr. Jackson was personally interested in his students. Once sensing a genuine and earnest interest, he gave of himself unstintingly. For him, such men were his friends, and he gave and received loyal support, which lasted throughout his life.

During his active years of research, he published numerous scientific papers, among which were those dealing mainly with fossil echinoderms, and larger publications, such as *Phylogeny of the Pelecypods*, *Localized stages in development in plants and animals*, and perhaps his most monumental work, *Phylogeny of the Echini*. His theory on evolution has been a valuable contribution to advanced science.

In addition to his life's work in science, he maintained a deep interest in horticulture, toward which he spent himself with enthusiasm and pleasure all his life. His garden, begun in his youth at his home in Dorchester, Massachusetts, was filled with a valued collection of plants and shrubs of many kinds. He specialized in the growing of peonies and irises.

From his friend and neighbor, John Richardson, he inherited his rare seedling peonies. These and many other plants he later transferred to his lovely garden in Cambridge, and again after twelve years, to his garden at Peterborough, New Hampshire. His pleasure and enthusiasm in the beauty of his and Mrs. Jackson's garden were untiring, and he never ceased in his delight in the production of a perfect specimen, be it peony, iris, or poppy, or any other plant under his care.

Dr. Jackson was a Fellow of the American Academy of Arts and Sciences, Boston Society of Natural History, American Society of Naturalists, Geological Society of America, and Paleontological Society.

JOSEPH A. CUSHMAN

Harvard University

Association Affairs

AAAS Officers—1949

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  - Chemistry (C): Edward F. Degering, Purdue University, Lafayette, Indiana
  - Astronomy (D): Charles C. Wylie, University of Iowa, Iowa City, Iowa (1948)
  - Geology and Geography (E): Leland Horberg, University of Chicago, Chicago, Illinois
  - Zoological Sciences (F): J. H. Bodine, University of Iowa, Iowa City, Iowa
  - Botanical Sciences (G): Stanley A. Cain, Cranbrook Institute of Science, Bloomfield Hills, Michigan
  - Anthropology (H): Marian W. Smith, Columbia University, New York, New York (1948)
  - Psychology (I): Delas D. Wickens, Ohio State University, Columbus, Ohio
  - Social and Economic Sciences (K): J. Frederic Dewhurst, Twentieth Century Fund, New York, New York (1948)
  - History and Philosophy of Science (L): Raymond J. Seeger, Bureau of Ordnance, Navy Department, Washington, D. C.
  - Engineering (M): Frank D. Carvin, Illinois Institute of Technology, Chicago, Illinois

Medical Sciences (N), Subsection on Medicine (Nm): Gordon K. Moe, University of Michigan, Ann Arbor, Michigan; Subsection on Pharmacy (Np): Glenn L. Jenkins, Purdue University, Lafayette, Indiana; Subsection on Dentistry (Nd): Isaac Schour, College of Dentistry, University of Illinois, Chicago, Illinois

Agriculture (O): E. E. DeTurk, University of Illinois, Urbana, Illinois

Education (Q): Dean A. Worcester, University of Nebraska, Lincoln, Nebraska

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President: Frederic H. Douglas, Denver Art Museum, Boulder, Colorado

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Book Reviews

Lehrbuch der inneren Sekretion. F. Verzár. Liestal, Switzerland: Ars Medici Ludin AG., 1948. Pp. xx + 608. (Illustrated.)

This textbook is an admirable introduction to the rapidly developing and expanding science of endocrinology. Dr. Verzár is a pioneer in this field and is particularly competent to undertake the difficult task of summarizing the methods and results of endocrinology in a relatively brief treatise. The American as well as the European literature is adequately and critically discussed.

It is not always possible to agree with Prof. Verzár as to the relative importance of the material included. For example, in a textbook of barely 600 pages, he devotes over 36 pages to the thymus gland, while secretin and renin get two pages each and enterogastron and cholecystokinin two paragraphs. There is no index.

The comparative physiologist as well as the clinician will profit greatly by this new textbook which could also be safely used as optional reading material in standard medical physiology courses. The book is recommended to all interested in the physiology of internal secretion and in the clinical possibilities of hormone therapy. The German style is lucid and can be easily followed by students acquainted with scientific German. An English translation would be highly desirable.

THEODORE KOPPANYI

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Crop management and soil conservation. (2nd ed.) Joseph F. Cox and Lyman E. Jackson. New York: John Wiley; London: Chapman & Hall, 1948. Pp. xxii + 572. (Illustrated.) $3.80.

Farm soils: their management and fertilization. (4th ed.) Edmund L. Worthen. New York: John Wiley; London: Chapman & Hall, 1948. Pp. xiii + 510. (Illustrated.) $3.20.

These books cover a broad field thinly. By inference, at least, they aim to deal with all agricultural regions of the United States. Actually, the center of attention is the eastern part of the Middle West, with something about the South and the Great Plains, and a bit about the West. Since an appeal is made to both farmers and young students, scientific language and principles are held to the minimum. Partly for this reason, full use is not made of the enormous body of technical knowledge acquired in the past two decades. Thus large parts of the books could be appropriately back-dated some 20 years.

In the book by Cox and Jackson, the first part of the title is treated more nearly adequately than the last. This book could have been recommended for high-school agricultural students if the discussions of soils had been omitted. But not enough helpful material is included on soils to offset the inadequacies.

Even though prepared for vocational agricultural students in high-schools, there can be no excuse for completely omitting the use of modern soil classification and published soil maps in arriving at specific recommendations for individual fields and farms. Again and again the reader is admonished to use crops and practices "adapted" to his soil. This is very good advice. But he is not told what these are nor even how he can find out. In fact, the reader is not even given a working concept of the principal kinds of soil in the United States or how he might learn about those of his own community or farm. One even finds statements like this: "Clay soils are usually poorly drained and hence tilling is necessary for sure production of corn, beans, and beets." Many soil types rich in clay do not need tilling, and many poor in clay do.

Terraces are generally recommended for sloping land. The authors fail to differentiate between those soils on which terraces would be useful and those on which they would be ineffective or even ruinous.

Fertilizer recommendations are exceedingly general—not specific to defined conditions—and are out of date. Little is said about the advantage of high-analysis kinds. For example, in the chapter on growing clover, one finds this: "On run-down and light soils, fertilizers containing potash as well as phosphorus, or complete fertilizers, such as 0-12-6, or a 2-12-4, are recommended." For years, agronomists and soil scientists have condemned such low-analysis materials. The very significant fertilizer and agricultural programs of the Tennessee Valley Authority are not even mentioned.

The part on crops is better but hardly up to date. The new methods for corn growing, involving closer spacing and supplemental nitrogen fertilization with adapted hybrids, are ignored. Modern methods for weed control with chemical sprays are mentioned but not explained.

Apparently the authors have tried to cover too much too fast. Thus, they avoid specificity, yet specificity is essential in farm management. The result is a mixture of old concepts and comparatively old practices, some good and some mediocre. It is far behind the modern successful farmer.

Farm soils is a more useful book. First of all, the author has confined his attention largely to soil management and thus not attempted to cover so much ground. Yet, relatively, it is less up to date than the earlier editions. Too much old material has been retained and not enough of the new results and new methods explained.

The author's concept of soil management is largely one of maintaining the soil. He writes that "farm soils tend to become acid." More often "farm soils" that need lime were acid at the start. Our problem with lime, organic matter, plant nutrients, and soil structure is, generally, as much or more one of improving the natural soils as it is of maintaining them.

The discussion of soil classification as a basis for predicting yields under alternative practices is outdated by 15 years or more. And even the system presented is not integrated with the recommendations in a way to permit these to be applied to specific conditions.

The moldboard plow is defended almost too much. Under dry-farming in regions of low rainfall he writes: "Therefore, plow to a depth of 7 or 8 inches promptly after crops are harvested." The greatly improved tillage methods now used by good farmers for the Chernozem, Chestnut, and Brown soils are inadequately explained.

This book is much better than *Crop management and soil conservation* on lime and fertilizer. Worthen stresses the savings to be made from home mixing of fertilizers and explains how it is done. He emphasizes the great savings resulting from the use of high-analysis materials rather than low-analysis ones. Yet, one wishes he had gone further and not written that "the 5-10-5, with a total of 20 percent of nitrogen, phosphoric acid, and potash, would class as a high-analysis or a high-grade fertilizer. . . ." But he shows the advantage of really high-analysis kinds. There are little errors such as "complete" for "mixed" fertilizer and "alkali" for "saline" soil. Generalizations are used where published data, if reviewed, would have permitted specificity.

Like the earlier editions, this book has a place for vocational agricultural courses in high schools and junior colleges, particularly in the humid-temperate part of the country. But it will need careful correction and supplementing by the teacher, using local soil surveys and recent bulletins of state agricultural colleges and the U. S. Department of Agriculture.

Two books are badly needed—one in agronomy and one in soil management—that can compare with *Farm management* by Black, *et al.* and *Feeds and feeding* by Morrison. Neither of these comes close to filling this need.

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Scientific Book Register

Bouma, P. J. *Physical aspects of colour: an introduction to the scientific study of colour stimuli and colour sensations.* New York: Elsevier, 1948. Pp. 312. (Illustrated.) $5.00.

Cohen, Morris R. *Studies in philosophy and science.* New York: Henry Holt, 1949. Pp. 278. $4.50.

Gold, Harry. (Ed.) *Cornell conferences on therapy.* (Vol. 3.) New York: Macmillan, 1948. Pp. xx + 337. $3.50.

Whelpton, P. K. *Forecasts of the population of the United States, 1945–1975.* (U. S. Dept. Commerce, Census Bureau.) Washington, D. C.: Govt. Printing Office, 1947. Pp. vi + 113. (Illustrated.) $.45.

(Continued from page 81.)

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NEWS and Notes

James W. McBain, professor emeritus of chemistry at Stanford University, has accepted appointment under the Central Government of India as director of the National Chemical Laboratories of India. The appointment is for an initial period of three years.

Jerome J. Howland, Jr., has become a member of the staff of Chemistry Department of Brookhaven National Laboratory. Dr. Howland has been performing research in nuclear chemistry at the University of California Radiation Laboratory.

H. S. Hulbert and **George Russell Agassiz** have been chosen patrons of the American Astronomical Society. Judge Hulbert was instrumental in the creation of the University of Michigan's McMath-Hulbert Observatory at Lake Angelus, near Detroit. Dr. Agassiz is vice chairman of the Committee to Visit the Department of Astronomy of the Board of Overseers of Harvard College.

Oskar Baudisch of the New York State Research Institute of the Saratoga Spa at Saratoga Springs, New York, is temporarily stationed at the U. S. Plant, Soil, and Nutrition Laboratory at Ithaca, New York, as a consultant in biochemistry. While there, he will conduct research on the relationship of cobalt to nutritional problems.

Thomas Addis, professor emeritus of medicine at Stanford University, is now a member of the Institute for Medical Research at Cedars of Lebanon Hospital, Los Angeles, where he will continue his laboratory investigations into problems related to renal diseases. He will collaborate with Harry Goldblatt, director of the Institute, in studies on the relationship between kidney function and high blood pressure, and with Jessie Marmorsten in studies of adrenal glands as related to the kidneys.

Paul R. Burkholder, Eaton professor of botany at Yale, is making a 15,000-mile trip throughout Latin America to collect soil samples for examination in his search for new antibiotics. The soil will also be analyzed for its agricultural qualities. Last year Dr. Burkholder discovered, in a sample of Venezuelan soil, the mold which makes the drug chloromycetin.

Fred Ordway has become a research associate at the National Bureau of Standards, on the staff of the Portland Cement Association Fellowship.

Herbert F. Traut, professor of obstetrics and gynecology at the University of California Medical School, will deliver the Annual Barnard Lecture at the St. Louis Medical Society Auditorium in St. Louis, Missouri, on February 1. Dr. Traut will speak on "Cytological Diagnosis of Cancer as It Applies to the Female Genital and Pulmonary Tracts."

Visitors to U. S.

Olaf E. Ryberg, lecturer at the Alnarp Institute, Akarp, Sweden, recently visited zoological and entomological laboratories in the United States, and attended the Washington meeting of the AAAS and the New York meeting of the American Association of Economic Entomologists. He will report to the Swedish government on the status of economic zoology and entomology in the U. S.

Albert Szent-Gyorgyi, Hungarian biochemist who won the 1937 Nobel laureate in medicine, is working as a special research fellow at the National Institute of Health, Bethesda, Maryland. Assisting him is **Koloman Laki**, another Public Health Service Fellow, who had worked with Dr. Szent-Gyorgyi at the University of Budapest.

Hideki Yukawa, physics professor at Kyoto Imperial University, and **Shizuo Kakutani**, professor and head of the Department of Mathematics at Osaka University, are now at the Institute for Advanced Study at Princeton, and recently lectured at Carnegie Institute of Technology.

Patrick L. Mollison, of the Postgraduate Hospital in London, England, who is visiting here, recently spoke at Duke University Hospital, on "Survival of Transfused Red Blood Cells."

Grants and Awards

The Oersted Medal of the American Association of Physics Teachers will be awarded Arnold Sommerfeld, 79-year-old German physicist at the Association's annual meeting in New York, January 27–29.

The Ernst Bischoff Company of Connecticut has made available a grant of $1,200 to Brooklyn College, to be used under the direction of Harry G. Albaum of the Department of Biology.

Forty-two Public Health Service Grants totalling $1,498,333 have been awarded to medical schools for developing or expanding undergraduate training in psychiatry. The first funds will be made available for the 1949–50 school year. Subsequent payments will be in annual allotments for the next two school years. In selecting the schools to receive grants, the Council favored those that were not receiving other mental hygiene grants from the Government and had not been able to establish a strong program but had potentialities for doing so.

Eta Kappa Nu, national honor society for electrical engineering, has selected Abe Mordecai Zarem, manager and chairman of physics research of the Stanford University Research Institute at Los Angeles, as the Outstanding Young Electrical Engineer of 1948. Jay Wright Forrester, associate director of the Servomechanisms Laboratory, Massachusetts Institute of Technology, and Milton E. Mohr, of the Bell Telephone Laboratories Technical staff in New York, were selected for honorable mention.

The Kirksville College of Osteopathy and Surgery has received a grant of $8,926 from the National Institutes of Health, U. S. Public Health Service, to continue electromyographic studies of single motor units. Three grants totaling $16,718 were also awarded by the Research Fund of the American Osteopathic Association, to continue studies of reflex activity in the spinal cord, to assist research on morphological variations of the motor end plate and visceral alterations resulting from alterations of the vertebral area, and to continue structural studies of the rural school children in Adair County, Missouri.

The University of Michigan recently announced grants amounting to $26,865 for research by University staff members. The grants, effective January 1, were made available from the Faculty Research Fund and the Horace H. Rackham Fund. H. M. Randall, professor emeritus of physics was awarded $3,000 for a study of the applications of infrared spectroscopy to biological research. A $2,500 grant for an inquiry into neuro-cellular generation of nerve impulses was made to Robert Gesell, chairman of the Department of Physiology in the Medical School. Among the other grants were two of $2,000 each: to Emmet T. Hooper, associate professor of zoology, and Floyd A. Peyton, professor of dentistry.

Fellowships

Applications for the newly created Howard Hughes Fellowships in Creative Aeronautics must be sent to the Dean of Graduate Studies, California Institute of Technology, Pasadena 4, California, before *February 15*, 1949. Open to qualified graduate students, the fellowships carry a stipend of $1,500 or more, plus $1,500 for tuition and research expenses and a salary of $2,000 or more for work at Hughes' Culver City aircraft plant.

The Institute for Numerical Analysis of the National Bureau of Standards, at the University of California, Los Angeles, is offering research fellowships for the summer of 1949 and the academic year 1949–50 to qualified graduate students now enrolled in accredited schools. Fellows will be expected to perform mathematical research aimed at methods for advancing applications of high-speed automatic digital computing machinery. Work done under a fellowship may be applied toward a thesis for an advanced degree. Stipends will be based on annual salaries of $2,294 for master's degree candidates and $3,727 for doctoral candidates. Further information and application blanks may be obtained from the Chief, Institute for Numerical Analysis, 405 Hilgard Avenue, Los Angeles 24, California.

Colleges and Universities

The New York University-Bellevue Medical Center has received a gift "in excess of $8,000,000" from the Samuel H. Kress Foundation. Under terms of the grant, the money will be used to develop a wide program of postgraduate medical education at the Center.

Southern Methodist University, will lay the cornerstone for its $2,000,000 Fondren Hall of Science on February 8. The construction of the all-science building, due to be completed this fall, was made possible by a gift of $1,000,000 from Mrs. W. W. Fondren of Houston, Texas. The building will house the Departments of Biology, Chemistry, Physics, Geology, and Geography.

A pilot plant to produce equilenin, a hormone that may be convertible into the male and female sex hormones, has been set up by the Wisconsin Alumni Research foundation at the University of Wisconsin. The value of equilenin, according to Wisconsin scientists, lies in the fact that it is the only hormone that can be made synthetically from coal tar products. The process being used is the result of basic research begun in 1941 under the direction of William S. Johnson of the University.

Meetings and Elections

The third annual meeting of the American Academy of Oral Pathology will be held at the Stevens Hotel in Chicago, February 6. Robert A. Moore, dean of the School of Medicine and professor of pathology, Washington University, will speak at the evening banquet.

The Kentucky Psychological Association will hold a two-session clinical meeting in Louisville, Kentucky, February 15. A second meeting, devoted to educational psychology and mental hygiene, will take place in Louisville in April, at the time of the Kentucky Education Association Meeting. A third meeting, devoted to research reports and association business, is scheduled on May 21 at the University of Kentucky.

The Section on Microbiology of The New York Academy of Medicine will conduct a symposium on certain aspects of the biology, metabolism, immunity, diagnosis and treatment of the more common parasitic infections, Tuesday evening, March 15, and Wednesday after and evening, March 16, at the Academy's headquarters, 2 East 103 Street, New York City.

The American College of Physicians will hold its 30th annual session March 28 through April 1 in New York City. Dr. Franklin M. Hanger, Jr., of New York City, is acting as chairman for local arrangements and the program of clinics and panel discussions, while the president of the College, Dr. Walter W. Palmer, director of the Public Health Research Institute of the City of New York, Inc., will be in charge of the program of morning lectures and afternoon general sessions.

The Sixth Western Metal Congress and Western Metal Exposition will be held in Los Angeles April 11–15, under the management of the American Society for Metals. A technical program on all phases of metal science is being developed in cooperation with the western sections of 20 other national technical societies. Latest developments and techniques will be displayed by manufacturers of basic materials, as well as processors of all types of industrial products. Further information may be obtained by writing to the American Society for Metals, 7301 Euclid Avenue, Cleveland 3, Ohio.

The 1949 Conference of Corrosion Engineers will be held April 11–14 in Cincinnati, Ohio. Forty-two technical papers will be presented at 11 symposia, on corrosion principles, chemical industry, electrical and communications industries, cathodic protection, pulp and paper industry, general industry, transportation industry, protective coatings, oil industry, salt water corrosion, and gas industry.

The Society of American Bacteriologists will hold its 1949 annual meeting May 16–20 in Cincinnati, Ohio. Walter J. Nungester, University of Michigan, will act as chairman of the program Committee; while Merlin L. Cooper, Cincinnati General Hospital, will serve as chairman of the Cincinnati Local Committee in charge of the meeting.

Recently elected officers of the Society for the 1949 term are: Wm. McD. Hammon, Hooper Foundation, San Francisco, president; Barnett Cohen, Johns Hopkins University, vice-president; and John E. Blair, Hospital for joint Diseases, New York City, secretary-treasurer.

The Fourth International Conference of the International Association of Quaternary Research will meet in Budapest August 22–September 15. Students of Pleistocene research—stratigraphy, anthropology, paleontology, geomorphology—are invited to attend. Two excursions, one to western Hungary and one to eastern Hungary, will be made. Full particulars may be obtained from the Hungarian Committee for INQUA IV, Hungarian Geological Institute, XIV Vorosilov-ut 14, Budapest.

The American Anthropological Association held its 47th annual meeting at the University of Toronto and the Royal Ontario Museum of Archaeology on December 28–30. Its newly elected officers are: A. Irving Hallowell, University of Pennsylvania, president; Harry Hoijer, University of California, Los Angeles, vice president; and John O. Brew, Peabody Museum, Harvard University, and Morris E. Opler, Cornell University, Executive Board members. Melville Herskovits, Northwestern University, took office as editor of the *American Anthropologist* beginning with 1949.

The Division of Biological Chemistry of the American Chemical Society has elected as chairman John T. Edsall, associate professor of biological chemistry at Harvard University. He succeeds Erwin Brand of the Columbia University biochemistry department. Jules D. Porsche, assistant director of the chemical research and development department of the Armour Laboratories, Chicago, was named vice chairman and Paul W. Preisler, associate professor of biological chemistry at Washington University, was chosen secretary, succeeding Dr. Edsall.

The Botanical Society of Washington has elected the following officers for 1949: Roland Bamford, president; H. A. Borthwick, vice-president; A. V. P. Smith, recording secretary; Vivian K. Toole, corresponding secretary; Wilbur D. McClellan, treasurer; and E. L. LeClerg and R. L. Weintraub, counsellors. John A. Stevenson was made archivist, and Freeman Weiss was nominated as representative to the Washington Academy of Sciences.

The Ninth General Conference on Weights and Measures

The General Conference on Weights and Measures, established in 1875 by the treaty known as the Convention of the Meter, held its ninth session in Sèvres, France, October 12 to 21, 1948. The regular interval between meetings of this Conference is six years, but the series of meetings had been interrupted by the war and no sessions had been held since 1933.

At its inaugural meeting the Conference was received by M. Robert Schuman in the historic Salon de l'Horloge at the Ministry of Foreign Affairs. The regulations provide that the President of the Academy of Sciences of Paris shall serve as President of the Conference. M. Henri Villat, the present President of the Academy, presided at some of the sessions. M. Louis de Broglie, Permanent Secretary of the Academy and head of the French delegation in the Conference, presided at others.

The Conference included fifty-five delegates appointed by twenty-eight of the governments which belong to the organization. Only five states had not sent delegates, two among them because they do not now have governments.

The International Committee on Weights and Measures, whose members are elected by the Conference, serves as a technical committee for the Conference. The Committee in turn is assisted by three special Advisory Committees dealing respectively with electricity, photometry, and thermometry and calorimetry. The International Bureau of Weights and Measures at Sèvres constitutes a permanent central office and laboratory for the Conference and the Committee.

A general report on the activities of the International Bureau during the past fifteen years was presented by the President of the International Committee, Mr. J. E. Sears of Great Britain. The Conference was then called upon to sanction the principal metrological results obtained during these fifteen years, including the final operations of the first periodic verification of national prototype meters and current determinations in the second periodic verification of the national prototype kilograms. With the exception of two kilograms which were well known to have been slightly reduced by wear, the new values reported to the Conference, both for the meters and for the kilograms, differed from the original values of 1889 only by amounts less than the possible errors of measurement involved. The historic "Kilogram of the Archives" was also included in these comparisons and showed a diminution of 0.4 milligram, which was not surprising in view of the character of the material from which it was made.

The idea of substituting a wavelength of light for the bar of platinum iridium which has been, and still is, the basic standard of length, is not new. However, this idea received at this meeting important support by the reports on production of elements consisting of a single isotope. These were mercury of mass 198 obtained in the United States by bombardment of gold 197 and in Sweden by electromagnetic methods of separation, and also krypton of masses 84 and 86 obtained in Germany with a purity of 99.9 per cent. By using these materials of single atomic mass one should be able to obtain spectral lines especially fine and of well-defined wavelength. The experiments reported confirmed this expectation but indicated that further studies will be necessary before one can consider making the change in the basic standard of length. The Conference reached this conclusion.

In view of the very large number of measurements which are being made of relative values of gravity, a determination of the absolute value of this quantity has assumed large importance. Preparations are being made at the International Bureau to make this determination by observations on a falling body in place of the pendulum which has served in all previous determinations. The Soviet and the Spanish delegations presented at the Conference similar proposals giving active support to this work.

The International Committee decided in 1946 to arrange for the introduction in all countries simultaneously on January 1, 1948, of absolute electrical units to replace the previously used international units. It likewise arranged for the substitution of a single unit of intensity of light, the ''candela'' (previously called ''bougie nouvelle'' or ''new candle''), based on the brightness of a black body, in place of the former units, the international candle and the hefner. These actions of the Committee were confirmed by the General Conference.

In meetings which preceded the Conference and prepared proposals for it everybody was found to be in accord on the adoption of the joule as the basic unit of heat, but some physical chemists wished to retain the calorie, and the relation of that unit to the joule presents a difficult question. The decision on this point adopted by the Conference was to ask only that those who still use the calorie shall give with their results all the information necessary to convert their results to joules.

Important changes of principle affecting the thermometric scale were accepted. The triple point of water is to replace the melting point of ice as the first fundamental fixed point, and it is forecast that the absolute zero in the Kelvin scale will be substituted for the boiling point of water as the second fundamental point. The International Temperature Scale which has been in course of development for so many years by the collaboration of the great national laboratories arrived this time at such a state that the qualification ''provisional'' is dropped. Temperatures in this scale are designated by ''°C'' or ''°C (Int. 1948)'' and the name of ''Celsius'' was adopted to replace the terms ''centésimal'' and ''centigrade.''

The most difficult question with which the Conference had to deal was one which troubles many men of different disciplines and many engineers, namely, the question of a practical international system of units. This question was presented to the Conference by the International Union of Physics, but the Conference did not feel able to settle it immediately, particularly because it did not have at hand sufficient information. The Conference, therefore, made no decision further than to charge its International Committee to undertake an official inquiry through the medium of the embassies and legations of the various countries which will be asked to report the opinions held in each country in scientific, technical, and educational circles on this question. As a base of discussion there was presented a detailed document prepared by the National Scientific and Permanent Bureau of Weights and Measures of France.

Undoubtedly in the fifteen years now passed in review the metric system has made considerable progress, but the agenda of the Conference was too full to permit presentation of the reports on this subject by different delegations and the International Bureau. Those interested are, therefore, referred to the article on this subject which will appear in the Proceedings of the Conference.

The International Union of Physics had published a list including a very large number of symbols, or abbreviations, which it recommended for magnitudes and for units. The Conference accepted only the list of symbols relating to units, with the exception of one, the atmosphere.

For the names of large numbers, the Conference recommended that countries in Europe, such as Belgium, Spain, France, Italy, Sweden, and Switzerland, abandon their present usage and adopt uniformly the practice of other countries, which seemed perhaps a little more logical. This other practice may be represented by the mnemonic formula $10^{6N} = (N)$ illion, according to which a billion is a million millions, a trillion is a million billions, etc. It was recommended also that numbers written in groups of three digits should have only a space between successive groups of three, the comma (according to French usage) or the period (according to British usage) being reserved to serve as a decimal point.

It is evident from the preceding account that the Ninth General Conference had a large amount of work to do. The discussions at the meetings took place in an atmosphere of reciprocal scientific understanding which developed more and more in the course of the sessions. It may be of interest only to note a slight incident which arose through the presentation of a motion by one of the delegations at the first working session looking to the exclusion of another delegation. The reasons advanced, which were of political nature, were easily cleared away in individual discussions and no further questions of this kind were raised. (*Translated from a short report by Albert Pérard, director of the International Bureau of Weights and Measures.*)

Deaths

Howard S. Fawcett, 71, authority on citrus diseases and professor emeritus of plant pathology at the Citrus Experiment Station, University of California, died December 12 at the Community Hospital, Riverside, California. Dr. Fawcett wrote the text *Citrus diseases and their controls* and contributed many articles to scientific journals. A charter member of the American Phytopathological Society, he received its highest honor in 1930 by election to presidency of the national group.

Raymond C. Martinelli, 34, associate professor of mechanical engineering at the University of California, died in Oakland, California January 9. Since 1946 Dr. Martinelli had done research for the Heat Transfer Section, Atomic Power Division of General Electric.

Gordon E. Richards, 63, professor of radiology at the University of Toronto, director of the Ontario Institute of Radiotherapy, and director of radiology at the Toronto General Hospital, died January in Toronto, Canada.

R. L. Jones, 62, vice president of the Bell Telephone Laboratories, and former director of apparatus development, died January 14 at his home in Summit, New Jersey.

Charles A. Marlies, 43, associate professor of chemical engineering at CCNY, engineering consultant, and author of the recently published *Principles of the high polymer theory*, died January 14 in New York City.

Harry Stack Sullivan, 56, psychiatrist and author, died in Paris, France, January 15, while enroute home from a charter meeting of the World Federation for Mental Health held in Amsterdam. Dr. Sullivan had served as editor of the journal *Psychiatry*, president of the William Alanson White Psychiatric Foundation of Washington, D. C., and director of the department of psychiatry, Georgetown University Medical School.

Josiah Charles Trent, 34, assistant professor of surgery at Duke University School of Medicine and chief of thoracic surgery, died December 10 at Durham, North Carolina. Dr. Trent was recognized for his writings and collection of books on medical history.

The Edwin Smith Surgical Papyrus, the oldest record of scientific medical knowledge in the world, has been recently presented to the New York Academy of Medicine by the New York Historical Society and the Brooklyn Museum. The 3,600-year old transcription of a medical treatise written more than 1,000 years earlier, was discovered in Luxor, Egypt, by Edwin Smith, a student of Egyptology, who recognized its importance to medical history. Following Mr. Smith's death in 1906, the papyrus was presented to the New York Historical Society by his daughter.

Written in ancient hieratic style, the text of the papyrus had first to be reproduced in hieroglyphics before an English translation could be made. This work was accomplished by the late James Henry Breasted of the University of Chicago, and published in 1930 in two volumes. One volume contains a facsimile in color of the entire papyrus, the other Dr. Breasted's translation and comments. The volumes, as well as the original papyrus, have been presented to the Academy by the Society and the Museum.

The author of the papyrus, whose name is unknown, was a physician who lived approximately 5,000 years ago when the Pyramids were being erected, and whose professional authority was so great that his works continued to be a scientific guide for medical practise for several millenia, according to Dr. Breasted. The papyrus deals entirely with surgery in a series of 48 illustrative cases and obviously records only part of the original treatise. The author's knowledge of anatomy was founded on human dissection and he already knew that blood flowed from the heart through the blood vessels to all parts of the body.

Through the International Exchange Program of the Department of State, given Congressional recognition by passage of the Mundt-Smith act on January 27, 1948, the U. S. Government now serves as a focal point in negotiating with other nations in the field of scientific and educational exchange. Office of Educational Exchange, established April 22, 1948.

The Division of International Exchange of Persons assists persons moving to and from this country for scholastic purposes and carries out Department responsibilities for certain programs involving the use of Government funds for the exchange of students, trainees, professors, research specialists, teachers, and lecturers. It also deals with the assignment of foreign specialists to certain projects and reviews requests for the loan of U. S. Government technicians made by foreign governments.

The Division of Libraries and Institutes augments the work of educational exchange by the dissemination of books, by maintaining libraries overseas, and by assisting U. S.-sponsored educational institutes abroad. The libraries make available American printed matter and library facilities, such as bibliographic and reference services, to foreign officials, scholars, writers, professors, and the general public. They maintain staff services for Foreign Service and the U. S. Information Service abroad.

The Interdepartmental Committee on Scientific and Cultural Cooperation is the coordinating unit for the educational exchange program. This Committee keeps advised of scientific and technical resources developed within this Government and assists other countries seeking advice on such subjects as agriculture, archival sciences, coast and geodetic surveying, fishery development, industrial research and standardization, library science, mining, metallurgy, and wildlife resource. Foreign governments contribute to the maintenance of these projects.

The University Maria Curie-Sklodowska, Lublin, Poland, is publishing the results of its scientific investigations in a series of volumes entitled *Annales Universitatis Mariae Curie-Sklodowska*. The annals comprise papers in natural science and related branches and are divided into the following sections: A—Mathematics, Physics and Chemistry; B—Geography, Geology, Mineralogy and Petrography; C—Biology; D—Medicine; E—Agriculture; F—Philosophy and Humanities. One volume of each section will be published each year, and several are now in print. Further information may be obtained by writing to the University, Plac Litewski 5, Lublin, Poland.

A report on Mental Hygiene Statistics, the first in a forthcoming series to be designated as the MH-S series, has been issued by the Division of Mental Hygiene, Public Health Service, Federal Security Agency, Washington 25, D. C. Statistics cover the normal capacity, percentage of overcrowding, full-time administrative staffs and expenditures for the maintenance of state hospitals for mental disease in 1946 by states and divisions of the U. S. The MH-8 series will make available the results of the annual *Survey of Patients in Mental Institutions* prior to the publication of a consolidated final report.

The radioisotope training facilities of the Oak Ridge Institute of Nuclear Studies have been opened to a limited number of scientists who are citizens of nations qualified to receive radioisotopes under the Commission's isotope export program.

The first foreign scientists selected for the program are K. Aterman, Department of Anatomy, University of Birmingham, England, and P. S. Krishnan of Madras, India.

A report on German wartime advances in infrared technology, available through the Office of Technical Services, Department of Commerce, reveals some German developments in the infrared field beyond those accomplished in the U. S. during the war. In concentrating on military applications, the Germans also perfected devices for photography, spectroscopy, and other uses promising wide industrial applicability. The report, PB 95308, *German War-Time Developments in Infra-red,* by T. M. Odarenko, was prepared in cooperation with University Laboratories, New York, and sells for $3 a copy. Orders should be addressed to the Office of Technical Services, Department of Commerce, Washington 25, D. C., accompanied by check or money order payable to the Treasurer of the United States.

The Optical Society of America has sponsored arrangements for two speaking tours among some of its local sections. On May 23, David Richardson, of the Bausch and Lomb Optical Company, will address the Detroit, (Michigan) Section on the topic, "The Ruling and Testing of Diffraction Gratings." Gordon F. Hull, Jr., of Dartmouth College, will give his lecture, "Microwave and Optical Analogues," before the Rochester (New York) Section on March 29, the Niagara Frontier Section on March 30, and the Detroit Section on April 1.

The search for emission B stars and planetary nebulae in the Milky Way, begun on Mt. Wilson thirty years ago, will be completed in South Africa during the next 3 years. The Palomar Observatories are loaning their 10-inch refractor telescope to the University of Michigan's Lamont-Hussey Observatory at Bloemfontein, South Africa for the survey, which will be carried on under the direction of Leo Goldberg, director of the University of Michigan Observatory. All of the Milky Way that can be photographed from Mt. Wilson has now been surveyed with red-sensitive plates and the remaining part will be studied from the Dark Continent.

An expedition under the direction of Archaeologist Axel W. Persson, of Upsala University, Sweden, will explore ruins of the town of Labranda, in Asia Minor, this summer. The ruins date from about 400 B. C. Professor Persson's aim is to establish a connection between Labranda's culture and that of the Minoan era in Crete, which ended about 1400 B. C. A Swedish government grant will aid the expedition.

The *Journal of the American Society of Agronomy* is now being issued under a new name, *Agronomy Journal,* which was adopted on January 1, coincident with the resignation of J. D. Luckett, editor of both the *Journal* and the *Proceedings of the Soil Science Society of America* for many years. His successor is Maurice R. Haag, formerly Experiment Station editor for the University of Wyoming. The editorial offices have been moved from Geneva, New York, to Madison, Wisconsin.

Make Plans for—

9th Pittsburgh Conference on Applied Spectroscopy, sponsored by Spectroscopy Society of Pittsburgh, February 18–19, Mellon Institute Auditorium, Pittsburgh, Pennsylvania.

Metropolitan Microchemical Society of New York, symposium, February 25–26, American Museum of Natural History, New York City.

Research Conference on Coccidiosis of the New York Academy of Sciences, March 3–4, American Museum of Natural History, New York City.

Recently Received—

A study of line intensities in the spectra of four solar-type stars, by K. O. Wright. (Publ. Dominion Astrophysical Observatory, Victoria, B. C., Vol. VIII, No. 1.) Ottawa: Edmond Cloutier, 1948. $.25.

Intensities of molecular bands in the spectra of three early R-type stars, by Andrew McKellar and William Buscombe. (Publ. Dominion Astrophysical Observatory, Victoria, B. C., Vol. VII, No. 24.)

You and your future at Aberdeen Proving Ground. Information about position openings obtainable from Civilian Personnel Division, Aberdeen Proving Ground, Maryland.

Report of the Naval Ordnance Laboratory, November 1948.

Cenco News Charts, No. 62. Published by Central Scientific Company, Chicago, Illinois, and featuring an article about the American Chemical Society.

Highlights. Published by the Eastman Kodak Company, Rochester, New York, and summarizing current news and information of interest to shareholders and friends of the Company.

Farm & Home Science. Published quarterly by the Utah Agricultural Experiment Station.

Social Science Research Council Items. Contains Council news and special social science articles.

Dow Corning Silicone Note Book (Fluid Series No. 3). Illustrated booklet issued by the Dow Corning Corporation, Midland, Michigan.

A survey of pumping in Illinois. (Highway Research Board Research Report No. ID.) Washington, D. C.: 2101 Constitution Avenue, 1948.

Energy from Fossil Fuels

M. King Hubbert, *Associate Director,*
Exploration and Production Research Division, Shell Oil Company, Inc.

I

THE EARTH MAY BE REGARDED as a material system whose gain or loss of matter over the period of our interest is negligible. Into and out of this system, however, there occurs a continuous flux of energy, in consequence of which the material constituents of the surface of the earth undergo continuous or intermittent circulation. For the present discussion we shall restrict our attention to the nonradioactive materials. The preponderance of the energy involved in this process is that derived from solar radiation, and a small fraction of the matter at or near the surface of the earth occurs in the peculiar aggregates known as living organisms. From geological evidence, organisms have existed upon the earth for probably as long as a billion years, and it appears that evolution had proceeded far enough that a species recognizable as *man* must have existed roughly a million years ago. The population of this species at that stage is unknown but evidently was not large. It existed in some sort of ecological adjustment with the rest of the organic complex, and competed with the other members of the complex for a share of solar energy essential to its existence. At that hypothetical stage its sole capacity for the utilization of energy consisted in the food it was able to eat—the order of 2,000 kilogram-calories per capita per day.

Emancipation from this dependence upon contemporary solar energy was not possible until some other and hitherto unknown source of energy became available. This had its beginning about the thirteenth century when some of the inhabitants of Britain made the discovery that certain black rocks found along the shore of the East Coast, and thereafter known as "sea coles," would burn. From this discovery there followed in almost inevitable succession the mining of coal and its use for the smelting of metals, the development of the steam engine, the locomotive, the steamship, and steam-electric power.

This development was further augmented when, about a century ago, the second large source of fossil energy—petroleum and natural gas—was tapped, leading to the internal combustion engine, the automobile, the aeroplane, and Diesel-electric power.

A third source of fossil energy, oil shale, although exploited on a small scale for almost a century, is only now approaching its phase of rapid development.

Rates of Production

It is to the rate of increase and the magnitude of the consumption of energy from fossil fuels that I now wish to direct your attention.

Consider coal. Although production statistics for the earlier periods are not available, it is known that from the initial discovery and use of "sea coles" to the present there has been a continuous increase in the rate of consumption of this commodity. During the eighteenth century the need for power for the coal mines led to the development of the steam engine, and the demand for better means of transportation led first to the railroad and then to the steam locomotive. We know also that before the end of the eighteenth century the employment of this new source of energy had reached such a magnitude in Britain as to produce the major social and economic disturbances referred to as the "Industrial Revolution."

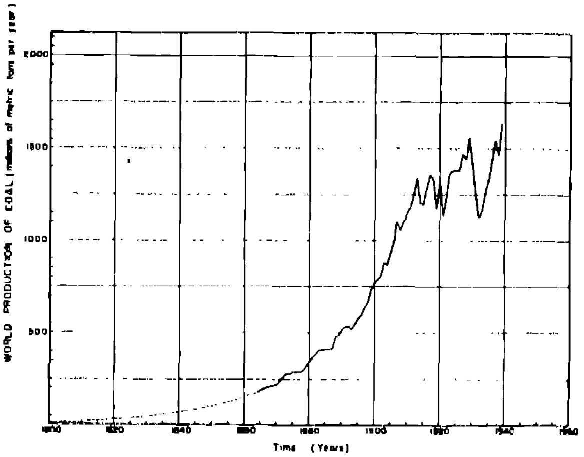

FIG. 1. World production of coal.

By 1864 (*11, 12*) (Fig. 1), from which date annual world production statistics are available, the annual production of coal in the world had reached about 180 million metric tons per year, and from that date until 1914, when it had reached a rate of 1,300 million tons per year, it continued to increase geometrically at a rate of 4 percent per year, or at a rate such that the annual production was doubling every 17 years.

"Energy from Fossil Fuels" was one of the papers presented as part of the Symposium on Sources of Energy, held in Washington, D. C., on September 15, during the Centennial Celebration of the AAAS.

The length of time during which coal has been mined is likely to be misleading. To appreciate the magnitude of what is happening and the brevity of time during which most of it has occurred, consider these facts: By the end of 1947 the cumulative production of coal during all past human history amounted to approximately 81 billion metric tons. Of this, 40 billion, or approximately one half, has been mined and consumed since 1920. Sixty-two billion, or more than three-quarters, has been produced since 1900.

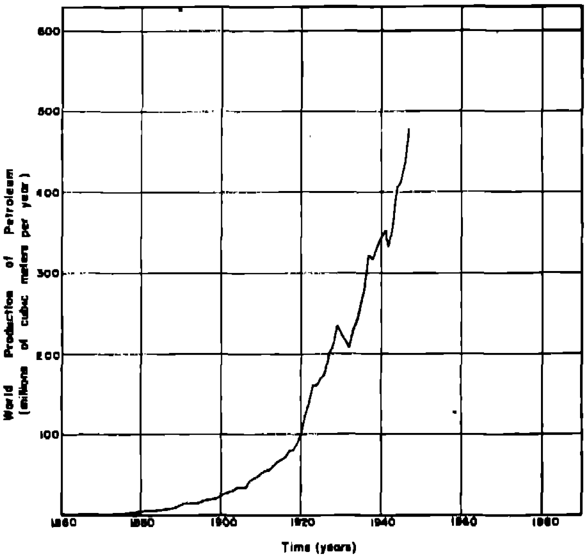

FIG. 2. World production of petroleum.

The world production of petroleum is shown graphically in Fig. 2 (*13*). The first commercial production of petroleum was begun in 1857 in Rumania. Two years later the first oil well in the United States was completed. From these beginnings, with only an occasional setback, the world production of petroleum has increased spectacularly, reaching by the end of 1947 an annual rate of 477 million cubic meters (3 billion U. S. barrels). From 1860 to 1929 the rate of production doubled, on the average, every 7½ years, or at an average annual rate of increase of slightly more than 9 percent. Since 1929 the rate of increase has declined somewhat and the doubling period increased to about 15 years.

Again, to emphasize the brevity of time during which most of this has occurred, the cumulative production by the end of 1947 was 9.17 billion cubic meters (57.7 billion U. S. barrels). Of this, one-half has been produced and consumed since 1937, or during the last 10 years, and 97 percent since 1900.

The energy content of the coal and petroleum which has been consumed, expressed in kilogram-calories, is shown in Fig. 3. From these two sources the energy per year amounted in 1939 to 15×10^{15}, or 15 thousand trillion, kilogram-calories per year, of which approximately four-fifths and one-fifth were contributed by coal and petroleum respectively.

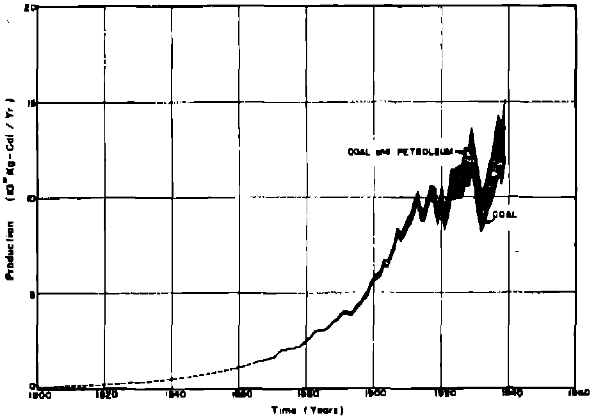

FIG. 3. World production of energy from coal and petroleum.

Because of the lack of world production statistics, the energy from natural gas has not been included. In the United States about 400 cubic meters of natural gas are produced for each cubic meter of oil, with an energy content of about four-tenths that of oil. Since oil and gas are genetically related it may be presumed that this approximate ratio is valid for the rest of the world also. Hence, the energy from the natural gas that has been produced may be assumed to be at least 40 percent of that of petroleum.

GROWTH OF POPULATION

One of the most disturbing ecological influences of recent millennia is the human species' proclivity for the capture of energy, resulting in a progressive increase of the human population (*4, 6*). This is borne out by the growth curve of human population since 1650, shown in Fig. 4, based on the studies of Carr-Saunders (*1*), and the recent estimate of Davis (*3*).

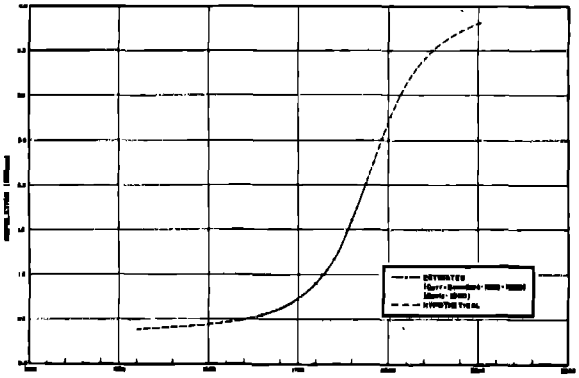

FIG. 4. Growth of world population.

According to these estimates the world population has increased from about 545 million in 1650 to 2,171 million by 1940. The greatest rate of increase during this period has been that of the last half-century, during which the world population has been increasing at such a rate as to double itself every century, or at an annual rate of increase of 0.7 percent.

Such a rate is not "normal," as can be seen by backward extrapolation. If it had prevailed throughout human history, beginning with the mythical Adam and Eve, only 3,300 years would have been required to reach the present population. If, on the contrary, we assume the human race to have been in existence for a million years, and to have increased at a uniform exponential or geometrical rate, starting with a single pair, the present population would have been reached in that time by a rate of increase of 2.1×10^{-4} percent per year, or a rate of growth that would require 33,000 years for the population to double. At such a rate it is doubtful whether any census could detect a change in the population during one man's lifetime.

That the present rate of growth cannot long continue is also evident when we consider that at this rate only 200 more years would be required to reach a population of nearly 9 billion—about the maximum number of people the earth can support. In fact, at such a rate, only 1600 years would be required to reach a population density of one person for each square meter of the land surface of the earth.

Prior to 1800 most of the energy available to man was that derivable from his food, the labor of his animals, and the wood he used for fuel. On a world-wide basis it is doubtful if the sum of these exceeded 10,000 kilogram-calories per man per day, and this was a severalfold increase over the energy from food alone.

After 1800 there was superposed on top of these sources the energy from fossil fuels. From a world average of 300 kilogram-calories per capita per day in 1800 the energy from coal and petroleum increased to 9,880 by 1900, and to 22,100 by 1940. In the areas of high industrialization this quantity is much larger. In the United States, for example, the energy from coal and petroleum consumed per day per capita amounted in 1940 to 114,000 kilogram-calories (*2*); and from coal, petroleum, and natural gas, to 129,000.

PHYSICAL LIMITS TO EXPANSION

From the foregoing data it should be clear that while we are concerned with a progression of ancient origin, the developments within the last century, and especially within the last few decades, are decidedly exceptional. One cannot refrain from asking, "Where is it taking us? How long can we keep it up?"

This leads us to consider what physical limitations there may be upon the various types of energy whose expansion we have noted. In the case of the fossil fuels the answer is simple. As remarked before, these fuels represent an accumulation over 500 million years of geologic time, and any additional accumulation that may be expected within the next 10,000 years is negligible. When these fuels are burned, their material content remains upon the earth in a relatively useless form, but the precious energy, after undergoing a sequence of degradations, finally leaves the earth as spent, long-wavelength, low-temperature radiation. Hence, we deal with an essentially fixed storehouse of energy which we are drawing upon at a phenomenal rate. The amount which remains at any given time equals the amount initially present less that which has been consumed already.

The amount consumed up to any given time is proportional to the area under the curve of annual production plotted against time. This area may approach but can never quite equal the amount initially present. Thus we may announce with certainty that the production curve of any given species of fossil fuel will rise, pass through one or several maxima, and then decline asymptotically to zero. Hence, while there is an infinity of different shapes that such a curve may have, they all have this in common: that the area under each must be equal to or less than the amount initially present.

AMOUNTS OF FOSSIL FUELS

While the quantities of fuels upon the earth are not known precisely, their order of magnitude is pretty definitely circumscribed. The most accurately known is coal. At the Twelfth International Geological Congress at Ottawa in 1913 a world review of coal was made and the amount capable of being mined was estimated to be about 8×10^{12} metric tons. Since that time some adjustments in the estimates have been made, giving us a present figure of about 6.3×10^{12} metric tons of coal initially present.

Within the last few years this figure has been criticized by mining engineers (*2, 5*) on the grounds that while the estimated amount of coal may in fact be present, the amount recoverable by practical mining operations is but a fraction—possibly as small as one-tenth—of the foregoing estimate. The degree of validity of this criticism still remains to be determined.

For petroleum the estimation is considerably less accurate than that for coal but still it is probably reliable as to the order of magnitude. The method of estimation in this case is that of sampling. In the better-known areas the amount of petroleum produced per unit volume of certain classes of rocks has been determined. The areas and volumes (within drillable depths) of similar rocks over the earth are fairly well known. By application of the same factor for the undrilled areas as for those now well known, an order of magnitude of the petroleum that may exist may be obtained.

The most comprehensive studies so far made public appear to be those of Weeks, which are cited by Wallace E. Pratt (*1-9*). According to these studies, in a volume of 10–12.5 million cubic kilometers (2.5–3.0 million cubic miles) of sediments in the United States there have already been discovered 8.4 × 10⁹ cubic meters (53 × 10⁹ barrels) of oil. This represents about 10 percent of the total volume of such sediments of the land areas throughout the world. Hence, it is estimated that for the world there should have been present initially about ten times as much oil as for the United States. A similar volume of sediments occurs on the continental shelves, which may contain about as much oil as the land sediments.

Assuming that the land areas of the United States will produce 16×10^9 cubic meters (100 billion barrels), then a reasonable estimate for the world would be:

Land:	160×10^9 m^3
Continental Shelves:	160×10^9 m^3
Total:	320×10^9 m^3

These figures are regarded as being somewhat liberal and the quantity of oil may actually be considerably less. Not included in the figures are the Athabaska Tar Sands (*8*), estimated to contain about 30×10^9 cubic meters of oil.

The amount of natural gas may be estimated at 400 cubic meters of gas for one of oil, or at an energy content of 40 percent that of oil.

The oil shales of the world are less well known. Those of the United States, especially the Green River shales, are estimated to contain at least 55×10^9 cubic meters of oil. Assuming that the rest of the world has about three times the amount of oil shales in the United States, we would obtain, for an order of magnitude, 160×10^9 cubic meters (1,000 billion barrels) of oil from this source.

The results of these estimates are given in Table 1 and shown graphically in Fig. 5. It will be noted that 92 percent of the estimated total is represented by coal—a figure which will not be greatly altered by any reasonable adjustments of the estimates of the remaining fuels, but may be considerably altered if the minable amount of coal is less than usually assumed.

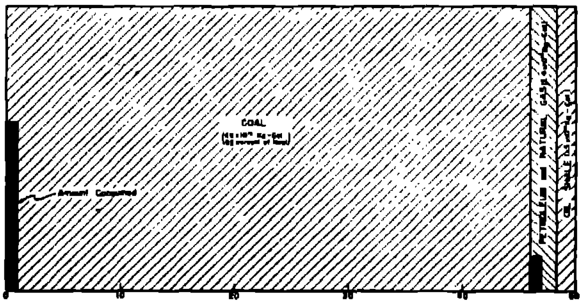

FIG. 5. Total energy of fossil fuels.

The amount of the initial coal already consumed is 1.35 percent; that of oil and natural gas, inclusive of the Athabaska Tar Sands, about 5 percent. The fraction of shale oil already produced is negligible. From these data the estimated initial supply of energy stored in fossil fuels is of the order of 50×10^{18} kilogram-calories, of which 0.7×10^{18}, or 1.5 percent, has already been consumed.

TABLE 1

ENERGY OF FOSSIL FUELS

Resource	Initially present		Percentage total initial energy	Already consumed		
	Quantity	Energy content (10^{18} kg-cal)		Quantity	Energy content (10^{18} kg-cal)	Initial (%)
Coal*	6.3×10^{12} metric tons	46.0	92.2	81×10^9 metric tons	0.59	1.3
Petroleum†	100×10^9m^3	1.5	3.0	9.17×10^9m^3	0.087	5.7
Tar Sands‡	30×10^9m^3	0.3	0.6	....	.....	...
Natural Gas§ ..	64×10^{12}m^3	0.6	1.2	3.7×10^{12}m^3	0.035	5.7
Oil Shale‖	160×10^9m^3	1.5	3.0	....	.....	...
Total	....	49.9	100.0	....	0.712	1.43

* Revised from estimate. Twelfth International Geological Congress (1913).

† Based on estimate of Wallace E. Pratt: "Petroleum on Continental Shelves" (*Bull. A.A.P.G.* 31, 1947, 657–672).

‡ Wallace E. Pratt. *Oil in the earth.* Lawrence: Univ. of Kansas Press, 1942. P. 44.

§ Based on gas/oil ratio of 400 m³/m³, or energy of gas = 0.4 energy of oil.

‖ Carl Belser: "Oil Shale Resources of Colorado, Utah and Wyoming" (*A.I.M.E. Tech. Publ. No.* 2358, May, 1948).

With this information we are prepared to consider what the future consumption of fossil energy may be. In Fig. 6 is shown the production of fossil energy up to the present, and two possible projections into the future. One production curve rises to a high peak and descends steeply; the second rises more slowly to a lower maximum and descends gently. The area under each curve, however, is approximately the same —10 unit squares, each of which represents 5×10^{15} kilogram-calories.

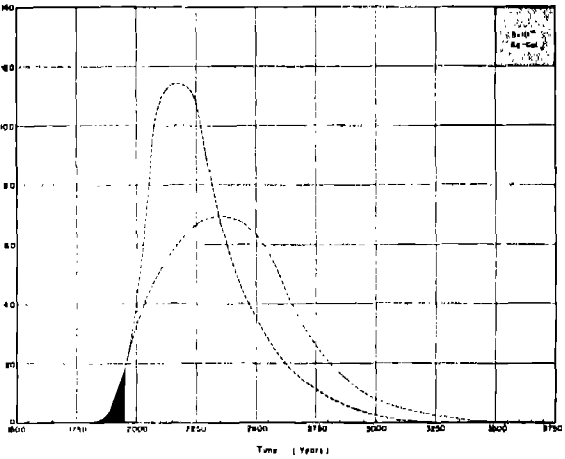

FIG. 6. Rate of consumption curves for fossil fuels.

If, as the coal mining engineers intimate, the amount of coal is much less than herein assumed, the area under the curve will be that much smaller and the approach to exhaustion that much sooner. How soon the decline may set in, it is not possible to say. Nevertheless the higher the peak of the production curve, the sooner and sharper will be the decline.

WATER POWER

The exploitation of water power, like that of coal, is of fairly ancient origin, but also like coal, until the last half-century its utilization has been small. Unlike fossil fuels, however, water power represents a fraction of current solar energy which changes but slowly with time, and is being continuously degraded into waste heat irrespective of whether it is utilized or not.

A growth curve of the utilization of water power, therefore, should rise in a manner similar to those of the fossil fuels, but instead of then declining to zero, it should level off asymptotically to a maximum as all available water power is brought into use. At least this is physically possible.

In view of the eventual exhaustion of fossil fuels, it is of interest to know to what extent water power can be depended upon to replace them. In Table 2 are listed the installed water power capacities of the various continents for the year 1947 and estimates of their total potential capacities (*10*), the number of kilowatt-hours of energy that such capacity should produce per year, and finally, the energy, expressed in heat units, of the amount of fuel that would be required to produce an equivalent amount of power.

In these calculations the potential installed capacity is taken to be equal approximately to the power at mean rate of flow and 100 percent efficiency. The estimated output is based on a load factor of 0.5, and the fuel equivalent of the power produced is based upon a thermodynamic efficiency of steam plants of 20 percent—figures which characterize installations in the United States at the present time.

TABLE 2

DEVELOPED AND POTENTIAL WATER POWER OF THE WORLD, 1947

Continent	Installed capacity*		Total potential water power				Potential output per year‡	
			Ord. min. flow*		Mean flow†			
	10^6 h-p	10^6 kw	10^6 h-p	10^6 kw	10^6 h-p	10^6 kw	10^{12} kw-hrs	Energy of equivalent fuel§ 10^{15} kg-cal
Africa	0.368	0.274	274	204	823	612	2.69	11.6
Asia	12.059	8.98	151	113	453	330	1.49	6.42
Europe	34.937	26.0	68	51	204	153	0.672	2.89
North America .	35.849	26.7	84	63	252	189	0.824	3.54
Oceania	1.284	0.955	20	15	60	45	0.197	0.85
South America .	2.892	1.79	67	50	201	150	0.658	2.83
Total	86.900	64.8	664	496	1992	1488	6.53	28.13

* U. S. Geological Survey, "Developed and Potential Water Power of the World" (1948).

† Computed on basis: average $\frac{\text{mean flow}}{\text{min. flow}} = 3$.

‡ Based on load factor of 0.5.

§ Computed on basis of efficiency of 20 percent for steam plants, or 4300 kg-cal/kw-hr.

The present and potential water power for the world is summarized graphically in Fig. 7. The potential capacity is about 1,500 million kilowatts of which present installations amount to only 65 million, or 4.3 percent.

The energy content of the equivalent fuel which would be required to produce the potential water power output is about 28×10^{15} kilogram-calories per year, or one and a half times the present rate of consumption of energy from fossil fuels.

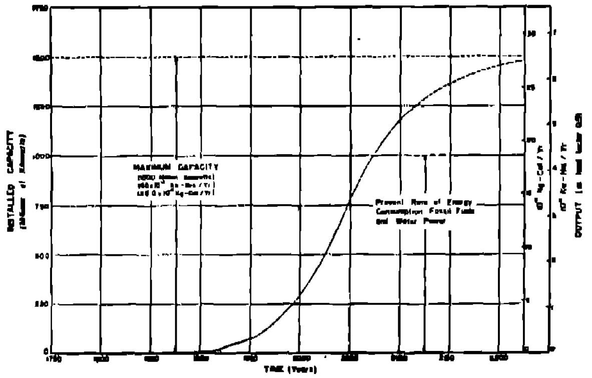

FIG. 7. World potential water power.

Hence, with maximum utilization, it would be possible with water power to supply to the earth an amount of energy comparable to that currently obtained from the use of fossil fuels.

TIME PERSPECTIVE

The present state of human affairs can best be appreciated in the light of a time perspective, minus and plus, of some tens of thousands of years from the present, as depicted in Fig. 8. On such a time scale the phenomena we have discussed are represented by abrupt, nearly vertical rises from zero or near zero to maximum values. The consumption of energy from fossil fuels is thus seen to be but a "pip," rising sharply from zero to a maximum, and almost as sharply declining, and thus representing but a moment in the total of human history.

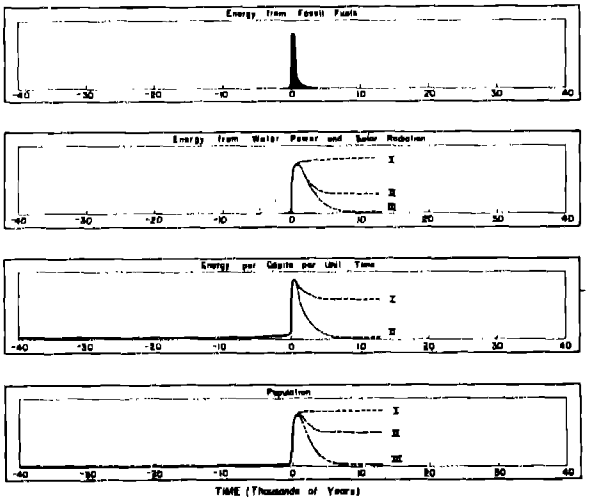

FIG. 8. Human affairs in time perspective.

The rate of consumption of energy from water power and solar radiation also rises almost vertically. It is physically capable of leveling off asymptotically to a maximum value as shown in Curve I and being held there more or less indefinitely. However, it is also possible that it may decline to some lower intermediate value as shown by Curve II, or to zero, as in Curve III, depending upon the state of human culture during the next few thousand years.

Likewise the consumption of energy per capita, after having risen very gradually from 2,000 to possibly 10,000 kilogram-calories per day, is seen to increase suddenly to a maximum value of several times the highest previous value. Again it is physically possible to maintain a high value, as indicated by Curve I, on a stable basis for an indefinite period of time from current energy sources, particularly direct and indirect solar radiation. It also is possible, however, that through cultural degeneration this curve may decline, as in Curve II, to the subsistence level of our agrarian ancestors.

Viewed on such a time scale, the curve of human population would be flat and only slightly above zero for all preceding human history, and then it too would be seen to rise abruptly and almost vertically to a maximum value of several billion. Thereafter, depending largely upon what energy supplies are available, it might stabilize at a maximum value, as in Curve I, or more probably to a lower and more nearly optimum value, as in Curve II. However, should cultural degeneration occur so that the available energy resources should not be utilized, the human population would undoubtedly be reduced to a number appropriate to an agrarian existence, as in Curve III.

These sharp breaks in all the foregoing curves can be ascribed quite definitely, directly or indirectly, to the tapping of the large supplies of energy stored up in the fossil fuels. The release of this energy is a unidirectional and irreversible process. It can only happen once, and the historical events associated with this release are necessarily without precedent, and are intrinsically incapable of repetition.

It is clear, therefore, that our present position on the nearly vertical front slopes of these curves is a precarious one, and that the events which we are witnessing and experiencing, far from being "normal," are among the most abnormal and anomalous in the history of the world. Yet we cannot turn back; neither can we consolidate our gains and remain where we are. In fact, we have no choice but to proceed into a future which we may be assured will differ markedly from anything we have experienced thus far.

Among the inevitable characteristics of this future will be the progressive exhaustion of the mineral fuels, and the accompanying transfer of the material elements of the earth from naturally occurring deposits of high concentration to states of low concentration dissemination. Yet despite this, it will still be physically possible to stabilize the human population at some reasonable figure, and by means of the energy from sunshine alone to utilize low-grade concentrations of materials and still maintain a high-energy industrial civilization indefinitely.

Whether this possibility shall be realized, or whether we shall continue as at present until a succession of crises develop—overpopulation, exhaustion of resources and eventual decline—depends largely upon whether a serious cultural lag can be overcome. In view of the rapidity with which the transition to our present state has occurred it is not surprising that such a cultural lag should exist, and that we should continue to react to the fundamentally simple physical, chemical, and biological needs of our social complex with the sacred-cow behavior patterns of our agrarian and prescientific past. However, it is upon our ability to eliminate this lag and to evolve a culture more nearly in conformity with the limitations imposed upon us by the basic properties of matter and energy that the future of our civilization largely depends.

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Analysis of Microcomposition of Biological Tissue by Means of Induced Radioactivity

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RADIOACTIVE ISOTOPES HAVE FREQUENTLY been used for the determination of reaction rates and distribution of chemical elements and compounds in the animal body; for example, the measurement of the total body water or the sodium space (*6, 7, 9*). Some of the radionuclides, however, cannot be used for determining the concentrations of their stable isotopes in tissue because the distribution of the administered radioactive tracer sample will not equilibrate, owing to absorption and excretion. On the other hand, the radioactive isotopes can be used to indicate the rate of turnover of substances in biochemical reactions. There are many important problems concerning "trace elements"[2] (e.g. see *11*) which involve knowledge of their distribution. The microchemical and spectroscopic methods of analysis which are now in use are not quantitative for most elements below 10^{-6} g/sample. It would be desirable to have methods of analysis which are accurate to well below this quantity. It seems certain that by using more highly sensitive methods of analysis much new information could be obtained concerning the biochemistry of trace elements in normal or diseased animals and plants.

Seaborg and Livingood (*10*) in 1938 solved a somewhat similar problem in their attempt to analyze for traces of gallium in iron. They exposed the gallium-contaminated sample to deuterons and determined the amount of gallium impurity by measuring the induced radioactivity. The use of this technique for biological studies was reported by us in 1947 (*12*) and later the same year by Brues and Robertson (*2*), who had used the technique independently. Clark and Overman (*3*) named the procedure "activation analysis." It may be used for biological research in more than one way. To learn the amount or concentration of various trace elements, one may take a sample of the tissue or tissue extract and, after proper processing, expose this sample to a source of nuclear particles, e.g. in a pile or cyclotron. Several of the elements present in this sample may become radioactive, and, after a known exposure, the amount of each newly formed radioactive isotope may be measured by standard radiochemical techniques. If a radioactive isotope A is formed from trace element B, the mass of the element B originally present in the sample may be calculated from the formula:

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[2] "Trace" elements are stable chemical elements, the presence of which, in small quantities, is essential for the lives of plants and animals. "Tracers" are radioactive or stable isotopes of elements which are suitable for study of the biochemical and physiological role of these elements or their compounds.

$$x = \frac{d \cdot A \cdot \varepsilon^{\lambda \cdot \tau}}{6.02 \cdot 10^{23} \cdot \sigma \cdot F(1 - \varepsilon^{-\lambda \cdot t})} \qquad (1)$$

where: x = unknown mass; A = atomic weight; F = particle flux; λ = decay constant of induced radioactivity; σ = cross section of B to form A; t = length of time of exposure to neutrons; τ = length of time elapsed between neutron exposure and time of measurement of rate of disintegration of the chemically separated sample A; and d = rate of disintegration of sample A measured at time τ.

The most convenient radiations to use are thermal neutrons produced by one of the chain-reacting piles. The above formula will hold true if the neutron flux remains constant throughout irradiation time, if the total amount of substance in the sample is not large enough to depress appreciably the neutron flux, and if the irradiation is not intense enough to significantly decrease the amount of isotope B to form isotope A. One does not always have to determine the absolute neutron flux in such a case. It is more convenient to measure the radioactivity induced after simultaneous irradiation of a known mass of element B. If neutrons are used as the activating agent, there are some 50 elements of biological importance which have large enough cross sections to make this technique an extremely sensitive one. Some of these elements are listed in Table 1.

Activation analysis may be also used for the study of distribution and metabolism of elements introduced into an organism in a manner somewhat analogous to radioactive tracer technique. Thus, for example, an element may be introduced into the circulation of an animal, and its distribution, excretion, etc. may be observed at some later time. Experiments of this kind may not be legitimately called tracer experiments because the amount of the element added to

TABLE 1

ESTIMATED DETECTION LIMIT OF ACTIVATION ANALYSIS FOR A FEW ELEMENTS, USING THERMAL NEUTRON CAPTURE REACTION*

Symbol of element	Atomic No. (Z)	Atomic Wt (A)	Natural atom cross section ($\sigma \times 10^{24}$ in cm²)	Half life of induced activity (T)	Length of exposure (t)	Time elapsed after exposure (τ)	Amt giving 10 sec⁻¹ disintegrations (gm)
Na	11	23	0.63	14.8 hr	5 T	T	2.4×10^{-9}
P	15	31	0.23	14.3 d	5 T	½ T	6.4×10^{-9}
K	19	41	0.067	12.4 hr	1 T	5 T	4×10^{-8}
Ca	20	44	0.013	180 d	0.02 T	T	2.2×10^{-7}
Sc	21	45	22.0	85 d	0.2 T	2 T	10^{-10}
Cr	24	50	0.5	26.5 d	0.4 T	3 T	5×10^{-9}
Mn	25	55	10.7	2.59 hr	1 T	5 T	1.8×10^{-9}
Fe	26	58	0.001	47 d	0.2 T	5 T	2.5×10^{-8}
Cu	29	63	2.0	12.8 hr	1 T	5 T	2.1×10^{-9}
Zn	30	64	0.26	250 d	⅕ T	⅗ T	4×10^{-8}
As	33	75	4.2	26.8 hr	1 T	5 T	1.2×10^{-9}
Br	35	81	1.11	34 hr	1 T	5 T	4.8×10^{-9}
Mo	42	98	0.1	67 hr	1 T	5 T	6.5×10^{-8}
Rh	45	103	137	44 sec	1 T	5 T	0.4×10^{-10}
Ag	47	109	1.1	225 d	0.05 T	0.3 T	1.6×10^{-8}
In	49	113	2.52	48 d	0.5 T	2 T	2.8×10^{-9}
Sb	51	121	3.8	2.8 d	1 T	5 T	2.4×10^{-9}
Te	52	126	0.15	9.3 hr	1 T	5 T	5.5×10^{-8}
I	53	127	6.25	25 min	1 T	5 T	1.8×10^{-9}
Cs	55	133	25.6	1.7 yr	0.002 T	0.1 T	2×10^{-9}
Ba	56	138	0.367	86 min	1 T	5 T	2.5×10^{-9}
Dy	66	164	725	140 min	1 T	5 T	0.15×10^{-10}
Pt	78	196	1.20	3.8 d	2 T	5 T	2.2×10^{-8}
Au	79	197	96.4	2.7 d	2 T	5 T	2.7×10^{-9}
Hg	80	202	0.725	51.5 d	0.2 T	T	2.6×10^{-8}

* Assumed neutron flux, that of the Clinton pile (8), $F = 5 \times 10^{11}$ cm⁻² sec⁻¹; assumed disintegration rate necessary for identification and measurement of each radioisotope, C = 10 sec⁻¹.

the organism must always be larger or of the same order of magnitude as the amount already present. The metabolism of the element, therefore, may be altered during the process. Nevertheless, valuable data may be obtained regarding distribution and metabolism of minute quantities of certain elements. In some instances, the use of radioactive isotopes for such purposes requires that the radiation dose delivered to the tissues during the experiment be small to avoid disturbing biological functions. If certain tissues concentrate or selectively absorb the isotope, it is sometimes hard to avoid high dosage of such tissues. To be able to measure the concentration of the isotope in other parts of the body, one must administer a large dose. In addition, some of the radioactive isotopes have too short half lives to permit their prolonged observation in animals; one would have to give a large dose of such a tracer in order to allow for its decay during the experiment. On the other hand, activation analysis does not have these limitations in measuring distribution of elements.

One of the most attractive features of the method described in this paper is its extreme sensitivity. Formula 1 indicates the factors influencing this sensitivity, and one may say that the most important of these is the flux of particles. Using the published value for the flux density of the Clinton pile (*8*), the sensitivity of the method can be calculated for some elements to be as much as 1,000 times greater than that by any other known method. Other advantages are that one can determine the amounts of several elements present in the same sample simultaneously and, finally, that the method has a high specificity for certain elements. One should emphasize that the method is quantitative and that it will not require special techniques for individual elements except those of radio-chemistry.

In order to test the practicability of the ideas outlined above, some experiments were done using elements whose chemistry is easy and well known. Since gold has an unusually large cross section for neutrons and since it is being used in this laboratory in connection with the study of rheumatoid arthritis (*1*), it appeared to be worth while to start with this element. The technique of its separation, deposition, and counting has been described by one of us (*5*). One normal female mouse, age six months, was injected in the tail vein with 10 µg of stable Au in the form of the soluble sodium gold thiosulfate salt. Upon autopsy and dissection a group of 19 repre-

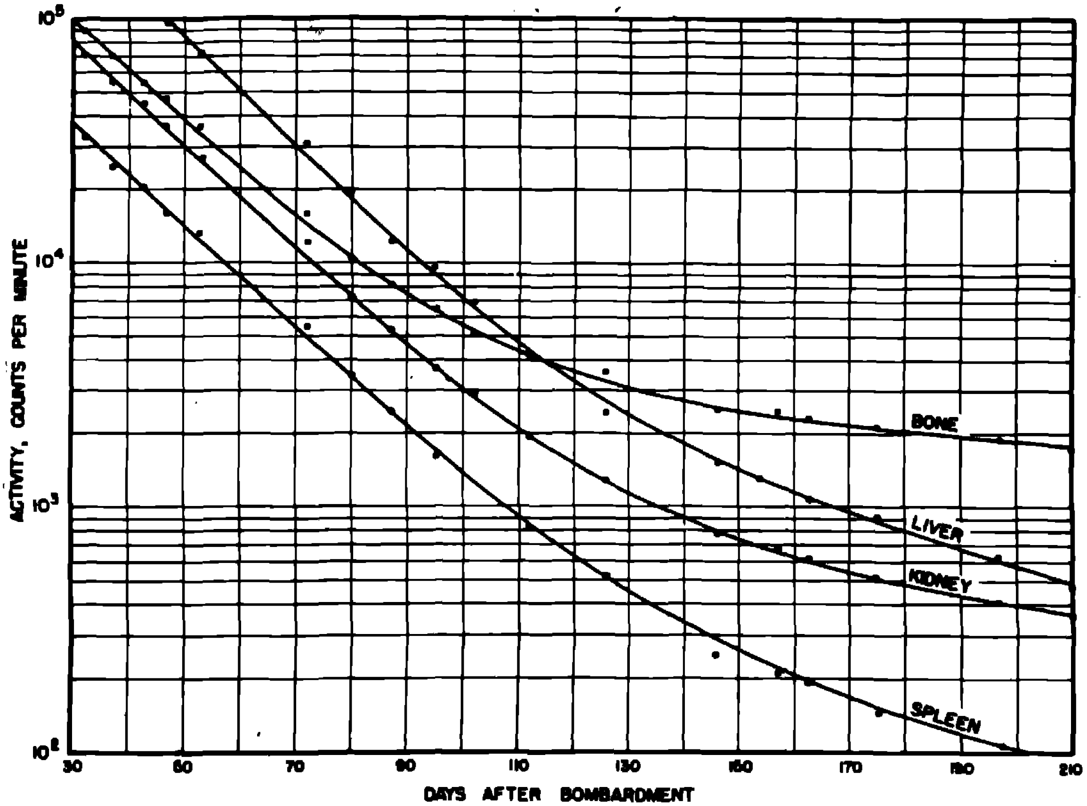

FIG. 1. Representative decay curves of bombarded tissue ash samples (mouse).

sentative tissue samples was selected. Each sample was wet ashed, then irradiated by slow neutrons in a pile.[3] After irradiation and a suitable cooling period, the ash was dissolved in aqua regia. A small portion was used to prepare samples for counting. Typical decay curves from the counting of the latter are to be found in Fig. 1. Since counting began about one week after irradiation, some of the important short-lived isotopes are not present in these curves (Na^{24}, K^{42}, etc.) The effective half life of several of the tissue ash samples was found to be between 14 and 15 days, which would indicate that the principal activity is due to P^{32}. By using the value of the counting rates obtained on the fourth day after removal from the pile, the relative activities of several of the samples were determined. These data, for the tissues of the mouse, are shown in Table 2, where the samples are listed according to decreasing radioactivity per mg of wet tissue. Also listed are the activities per mg of estimated dry ash. The radioactivity per unit wet weight is roughly proportional to the phosphorus content of each organ, while the relative activity per mg dry ash weight is almost constant for most organs, indicating that the ash has an approximately constant percentage of phosphorus. At the end of 90 days the radioactivity of phosphorus decreased sufficiently to make some of the longer-lived components appear.

TABLE 2

RELATIVE RADIOACTIVITY OF IRRADIATED ASH ONE WEEK FOLLOWING EXPOSURE TO THERMAL NEUTRONS

Tissue	Wet wt (mg)	Estimated ash wt (mg)	Relative activity*/ mg of ash wt
Bone	20.8	7.9	1,000
Pancreas	179.6	3.9	1,500
Kidneys	305.0	3.9	1,720
Thymus	61.8	0.8	1,600
Spleen	141.4	2.7	1,110
Liver	1,458.8	57.0	500
Brain	486.1	6.8	1,220
Heart	107.2	1.1	1,780
Lung	175.2	2.1	1,500
Ovaries	21.8	0.3	1,110
Adrenals	11.6	0.2	830
Lymph nodes	80.8	0.2	1,800
Muscle	70.4	0.9	1,060
Red cells	0.15 (ml)	3.0	195
Gall bladder	14.6	0.1	830
Skin	101.6	5.1	145
Tendon	5.4	0.4	78
Gut	3,832.7	64.0	244
Plasma	0.15 (ml)	3.0	11.1
Control sample tube (empty)	very small	very small	......

* Mean of measurements on two samples.

Another portion of the solution was used to make radiochemical separations of various elements, in order to study the distribution of these elements and the administered gold. The first part of this work, namely, the study of the distribution of gold, is now complete. The activated gold was separated from each sample by precipitating it, with carrier, as the metal. The activities were determined after electroplating on platinum planchets. The half life of each sample was calculated. The values obtained showed that excellent separation of the Au^{198} activity had been obtained. Typical decay curves are shown in Fig. 2. Table 3 gives the results of the distribution of radioactive gold. To some extent, these parallel the data obtained with mice injected with Au^{198}. Twenty-three per cent of the gold injected was recovered, which indicates that the rest of it was excreted in the one-month period. In the determination of the gold distribution a monitoring sample was used. This was prepared by simultaneously irradiating 10 μg of pure gold, as the chloride, with the same flux of neutrons as was received by the samples of mouse tissue. The activity of this gold sample was also used to calculate the neutron flux of the pile, since the cross section of Au^{197} for neutron capture is known.

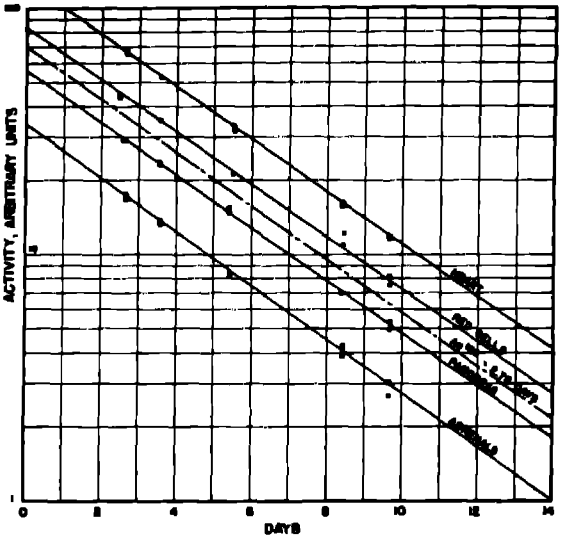

FIG. 2. Representative decay curves of Au^{198} recovered from tissue samples which were wet ashed and then bombarded by neutrons.

In another experiment 20 ml of blood from a leukemic patient was fractionated into plasma, white cells, and red cells. These three ashed samples were also irradiated in the pile. The activity of the blood fractions, shown in Table 4, indicates that the relative radioactivity induced in the white cells per mg of dry ash weight is about 10 times as high as that induced in red cells, or 50 times as high as the radioactivity induced in the plasma. Our attention is now focused on isolating the several isotopes which are responsible for the white cell radioactivity. The powerful possibilities which this technique offers are clearly illustrated in Table 5, which lists the Au found in the blood of a leukemic patient. The computations give 14 μg of gold for the total white cell volume of the body. To determine this small amount, one need use only about 10 cc of blood.

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[3] Curtis and Teresi have previously demonstrated various radioactivities induced in tissues by neutrons (4).

TABLE 3

DISTRIBUTION OF GOLD IN A MOUSE*

	Mass of organ (gm)	Amt of Au^{197}/gm of wet tissue (gm)	Total amt of Au^{197}/organ (gm)
Monitor gold sample	.....	....	10×10^{-6}
Liver	1.458	4.4×10^{-7}	640×10^{-9}
Ovary	0.022	4.3×10^{-7}	9.5×10^{-9}
Thymus	0.062	3.2×10^{-7}	19×10^{-9}
Adrenals	0.012	3.1×10^{-7}	3.6×10^{-9}
Lung	0.175	2.6×10^{-7}	46×10^{-9}
Lymph nodes	0.031	2.2×10^{-7}	6.8×10^{-9}
Spleen	0.141	1.7×10^{-7}	24×10^{-9}
Kidney	0.306	1.6×10^{-7}	49×10^{-9}
Heart	0.107	1.5×10^{-7}	16×10^{-9}
Bone	2.000	1.1×10^{-7}	290×10^{-9}
Pancreas	0.015	1.1×10^{-7}	1.6×10^{-9}
Skin	3.100	1.0×10^{-7}	310×10^{-9}
Gall bladder	0.015	1.0×10^{-7}	1.5×10^{-9}
Tendon	0.050	0.7×10^{-7}	3.5×10^{-9}
Muscle	11.20	0.65×10^{-7}	730×10^{-9}
Red & white cells ..	1.05	0.66×10^{-7}	69×10^{-9}
Brain	0.502	0.2×10^{-7}	10×10^{-9}
Gut	3.6	0.09×10^{-7}	32×10^{-9}
Plasma	1.0	0.05×10^{-7}	5×10^{-9}
Total	25.446	....	2276.5×10^{-9} gm or ~ 23% of total injected

* 10 μg of stable gold administered intravenously to a mouse in the form of gold sodium thiosulfate.

Mouse sacrificed 30 days after administration, tissues wet ashed and irradiated in the Hanford pile.

Subsequently the gold was removed by radiochemical methods, and its half life and beta-ray energy verified and counted in duplicate samples.

TABLE 4

RELATIVE RADIOACTIVITY OF IRRADIATED BLOOD ASH FROM A PATIENT WITH LYMPHOID LEUKEMIA
(One week after exposure to neutrons)

Tissue	Estimated ash wt used in determination (mg)	$\frac{\text{Relative activity*}}{\text{mg of ash wt}}$
Red cells	114	1
White cells†	8	11
Plasma	280	0.2

* Mean of measurements on two samples.

† The white cells were prepared by centrifuging with beef albumin.

These considerations and experimental data indicate that microanalysis of tissue constituents by induced radioactivity may become a useful technique for the determination of ultramicro amounts of a number of elements. It is expected that the technique will play an important role not only in tracer biochemistry but in plant nutrition, pharmacology, and toxicology as well.

TABLE 5

DISTRIBUTION OF GOLD IN HUMAN BLOOD FROM A LEUKEMIC PATIENT

	Estimated wet mass in body (gm)	Gm of Au^{197}/gm of wet mass	Total Au^{197} in circulation of person (gm)
White cells	130	11×10^{-8}	14.3×10^{-6}
Red cells	2,600	0.4×10^{-8}	10.5×10^{-6}
Plasma	2,650	0.07×10^{-8}	18.5×10^{-6}

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TECHNICAL PAPERS

Creation of a "σ" Meson by a Highly Ionizing Nucleus in the Cosmic Radiations[1]

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Department of Physics, University of Chicago

A 100-μ-thick boron-loaded Ilford C2 plate was exposed to the cosmic radiation through the use of free balloons which remained at altitudes corresponding to pressures between 4 and 6 cm of Hg for 11 hrs.

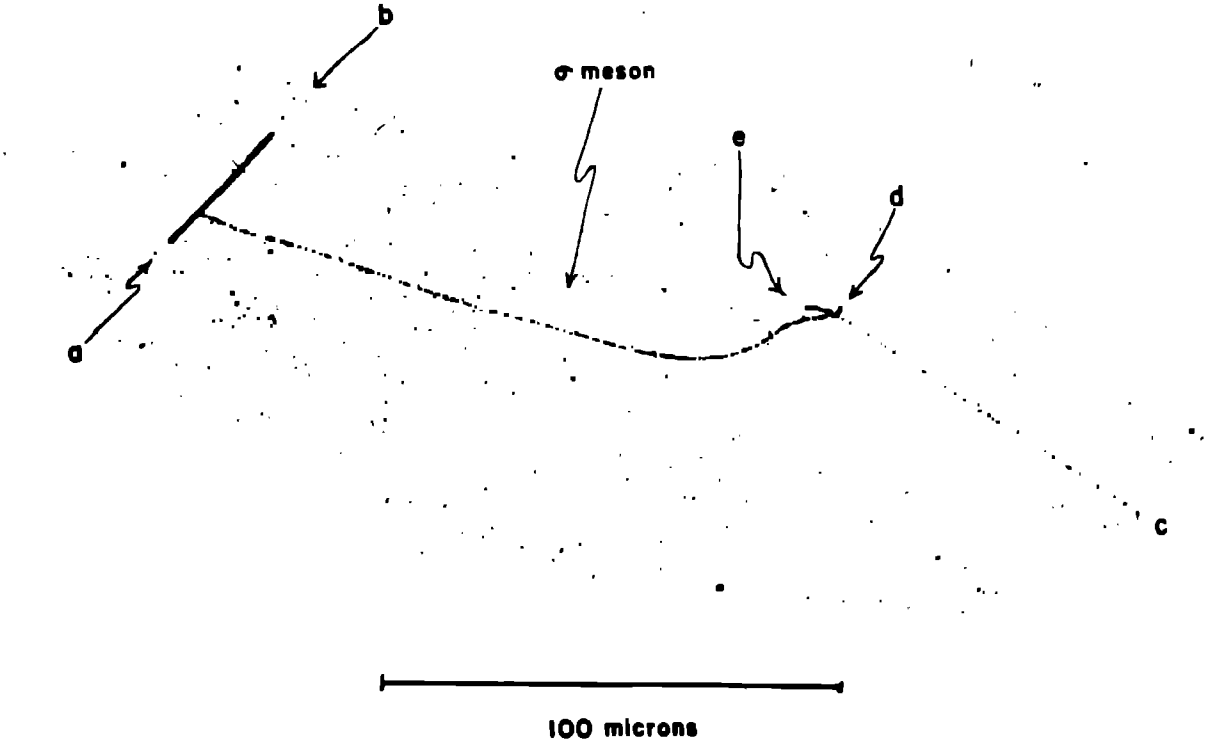

FIG. 1.

The mosaic of microphotographs in Fig. 1 shows an example of an unusual case of the production of a "σ" meson in the emulsion of this plate. The elementary act in which this meson was produced differs from those found by Powell and his collaborators (*2*).

A column of silver grains passes steeply (64°) from the top of the emulsion (a) completely through the emulsion and into the glass backing at (b). At a point on this column 26 μ from the upper surface, a "σ" meson originates and travels 158 μ, where it stops and is captured, producing a nuclear disintegration in which the visibly ionizing particles (e), (d), and (c) are emitted. Fig. 2 is a drawing in which the tracks in this event have been projected on the plane defined by the tangent to the meson track at the point of creation and the silver column from (a) to (b). The grain densities of sections (a) and (b) are considerably greater than those corresponding to protons or alpha particles capable of creating a meson of mass energy which is known from measurements with the synchrocyclotron in Berkeley, California, to be 143 mev. Section (b) of the column appears to be slightly more dense than (a). This small difference, however, may be due to a loss in resolving power of the microscopic system when viewing grains at greater depths beneath the surface of the emulsion. An upper limit to the difference in the grain densities above and below the point at which the meson is created is certainly less than 10%. The measured deviation of the

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[1] Assisted by the joint program of the Office of Naval Research and the Atomic Energy Commission.

column from (a) to (b) is less than 1°, which is about the deviation expected for a straight track of 110 μ due to emulsion distortions in the central regions of a plate.

It seems impossible that this meson is produced in a nuclear disintegration of the ordinary type in which the only other visible tracks, (a) and (b), of nearly the same grain densities travel in opposite directions along a straight line. This strongly suggests that the track from (a) to (b) is due to a single particle passing through the emulsion which interacts with one of the nuclei in this emulsion to create a meson. This is further augmented by the existence in this emulsion of several other heavy nuclei tracks of the same character as reported previously (*1*). This was shown by tracing the passage of 8 of these particles down through a 0.325-cm-thick lead plate and into a similar photographic emulsion. Two of these were followed on through an additional 3.9 cm of lead into another photographic emulsion.

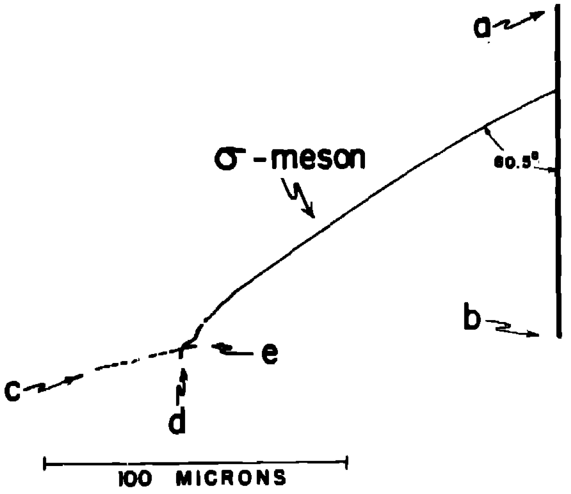

FIG. 2.

The track from (a) to (b) in Fig. 1 could not be traced through the 0.325-cm lead plate, and this places an upper limit on the range of the particle producing the meson. This, coupled with the small change of less than 10% in the ionization after the creation of the meson, shows that the particle had a maximum energy of several bev at the point where the meson was created and a nuclear charge between 7 and 20 unit electronic charges.

The absence of a large nuclear disintegration demonstrates that the meson was created in a pure nucleon-nucleon interaction. This seems to indicate that nuclei can be greatly transparent to the bombardment of stripped nuclei of energies capable of producing a meson.

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Analysis of Insect Food Habits by Crop Examination

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Department of Biology,
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It has been common practice for many years to determine the food habits of birds and mammals by examination of crop or stomach contents, but there appears to have been no effort to apply the same technique systematically to the study of the food habits of insects. Recent studies, however, demonstrate clearly both the feasibility of the technique and its value in determining food habits under natural conditions.

The technique is probably applicable to all insects with chewing mouth parts, but in the studies here reported has been limited to various types of Orthoptera. In the Orthoptera, even those with graminivorous- rather than carnivorous-type mandibles (*2*), the food is not so finely divided when it reaches the crop but that much can be learned of its character from examining the fragments. Whether leaf fragments are from forbs or narrow-leafed plants can readily be determined by the character of the epidermal cells of the plant fragments found in the crop. Even those grasshoppers that feed exclusively on grasses and have graminivorous mandibles swallow relatively large bits of grass. Some plant fragments may be quite accurately identified—pollen grains, for example. Fragments of insects permit various degrees of identification: scales of Lepidoptera may be intact; wing fragments of smaller insects may show characteristic patterns of venation; or mouth parts and leg parts may be distinguishable. In other words, the natural diet of an insect species may be determined, at least qualitatively, from the examination of collected specimens. This means that one need not have recourse to laborious methods of experimental testing, at least for preliminary studies of food selection, and in some cases this technique may prove entirely adequate for both quantitative and qualitative determinations of food habits. Since field observation has not proved a successful means of judging food choice and since such observation has led to many errors, it appears probable that the method of crop analysis may prove a valuable guide to food habits of many species. It has already yielded significant results for certain orthopterans.

The feasibility of this technique is due to the fact that the food eaten by an orthopteran accumulates in the thin-walled expansible crop, where it undergoes little digestion before passing into the next division of the digestive tract. The esophagus in the Orthoptera merges directly into the crop, which may or may not be rather definitely separated by a constriction from the next section, the proventriculus. In the Gryllidae and Tettigoniidae (e.g., *Conocephalus*, see Fig. 1) the constriction is quite evident; in the Acridiidae it is less noticeable. In either case, however, food accumulates in the crop in a state of incomplete mastication. Examination of the crop contents may be most simply carried out by pulling off the head of the freshly killed insect. The digestive tract, at least the anterior part, will remain attached to the head. In crickets, katydids, and meadow grasshoppers the tract usually breaks at the constriction forming the posterior boundary of the proventriculus. In the short-horned grasshoppers practically the entire tract may be pulled out with the head. In either case, the crop may be opened at the anterior or posterior end and its contents pushed out. Teased apart in a drop of water on a microscope slide, the contents are ready for examination. The crop contents of specimens collected years before can be examined successfully if a little more care is observed. The contents of the crop, either from fresh or dried material, if placed under a sealed cover glass in 40 parts of 10% formalin and 60 parts of glycerine, can be studied at leisure.

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[1] Prof. Isely died December 30, 1947. This report was prepared by the junior author from his notes and supplementary observations.

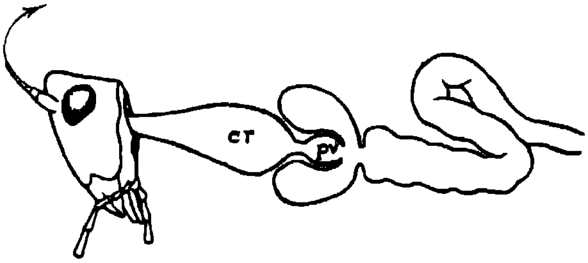

FIG. 1. Head and digestive tract of *Conocephalus fasciatus*, approximately 3 times natural size. The crop (cr) is distended as it is when filled. When the tract is pulled out with the head, it usually breaks at the indentation just posterior to the proventriculus (pv).

The value of crop analysis is well illustrated by the fact that studies recently carried out on several species of meadow grasshoppers (Conocephalinae) show conclusively that insects constitute a part of their normal diet. Certain other members of the Tettigoniidae, particularly decticids, are known to be carnivorous (*3*). The carnivorous habits of the meadow grasshoppers, on the other hand, while known, have been considered aberrant modifications of the normal feeding behavior (*1*). These first studies, which are to be reported in extended form elsewhere, show further that the vegetative parts of plants are rarely, if at all, eaten by these Conocephalinae. These insects subsist on flowers, pollen, and seeds of grasses, in addition to insects, normally deriving little if any food from the leaves of either the grasses or the broad-leafed plants among which they live. Inasmuch as it has been assumed, largely on the basis of analogy, that meadow grasshoppers exert significant pressure on meadow vegetation (*4*), the method of crop analysis has in this case demonstrated that the biotic role of this group of insects is quite different from that which has been assumed for it for many years. These species, which we have believed harmful, may, on the basis of these studies, be considered beneficial, or at least neutral, in their ecological role. An expansion of this technique to the study of the food habits of other species may yield equally interesting and significant results.

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Evidence That Two Different Plant Viruses Can Multiply Simultaneously in the Same Cell[1]

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It is well known that a plant may harbor two or more viruses at the same time. Indeed, infection of a plant with two nonrelated viruses, which alone cause only mild symptoms, sometimes results in a severe disease. Thus, mild tobacco mosaic and potato mottle viruses together produce a serious disease of tomato known as streak (*7*). It has been presumed, but not proved, that two such nonrelated viruses may occupy the same cell. Experiments reported here demonstrate the presence of inclusions of both tobacco mosaic and tobacco etch viruses in a large number of cells of doubly infected tobacco plants. Since these inclusions are closely associated with the respective viruses, their presence together indicates that the viruses increased simultaneously in the same cell.

The type strain of tobacco mosaic virus, which we used, forms abundant hexagonal crystals in the cytoplasm of its host. The mild strain of tobacco etch virus likewise produces crystals, often plate-like, but easily differentiated from those of tobacco mosaic virus, being different in size, form, and location. They occur characteristically in the nuclei but can sometimes be seen in the cytoplasm. Such inclusions were first described for the severe strain of tobacco etch by Kassanis (*4*).

The crystalline inclusions are usable for identifying tobacco mosaic and tobacco etch viruses within cells. Each of these viruses forms, in the cytoplasm, amorphous bodies which McWhorter (*6*) has designated as *viroplasts*. The viroplasts vary in structure; those of tobacco mosaic cannot always be distinguished from those of tobacco etch. They are not, therefore, readily usable for identifying the respective viruses within cells.

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[1] Aided by a grant from the National Foundation for Infantile Paralysis.

[2] Senior Research Fellow, University of Pittsburgh, from January to May, 1948.

Nicotiana tabacum L. and *N. sylvestris* Spegaz. and Comes were used as host plants for this study. They were inoculated with the two viruses either simultaneously or at intervals of one and four days. Controls consisted of plants inoculated with only one virus. The macroscopic symptoms of tobacco etch usually developed from one to three days before those of tobacco mosaic. Symptoms of both viruses were easily seen in doubly inoculated plants during onset and up to two or three weeks after inoculation. Later, symptoms were predominantly those of etch, doubly infected plants being distinguished from those infected with etch alone merely by a slight reduction in size.

Slides for microscopic examination were prepared by cutting thin slices of tissue, with trichomes attached, from the veins and edges of leaves, and mounting the tissue in 0.85% NaCl. Cytological examinations were made on the 11th and 40th days after inoculation.

The size and location of leaves wherein complete expression of cytological symptoms regularly occurred were determined for both viruses by examination of control plants. Corresponding leaves of doubly infected plants were then studied to determine the distribution of the two viruses in individual cells. The first cytological examination revealed the presence of crystalline inclusions of both viruses in every observed integumentary cell of such leaves from simultaneously inoculated plants. This was not entirely true for corresponding leaves of plants inoculated first with one virus and four days later with the other. In such plants, cells of leaves near the point of inoculation showed inclusions dominantly or entirely of the primary virus only. Cells of leaves higher up the plant, however, nearly always showed inclusions of both the primary and the challenge virus.

When the plants were reexamined 40 days after inoculation, again nearly every observed cell of appropriate leaves showed crystalline inclusions of both viruses. In many cases, leaves near the tops of the plants showed only tobacco etch inclusions while those lower down the plant showed both. This observation suggests that inclusions of etch develop sooner than those of mosaic in old plants and may help explain the dominance of etch symptoms.

The hexagonal plates of tobacco mosaic are known to be closely associated with tobacco mosaic virus. Likewise, the intranuclear crystalline inclusions of tobacco etch are closely associated with tobacco etch virus. Since it is very unlikely that the materials composing these inclusions were formed in distant cells and transferred in toto to the many cells where they were found occurring together, the evidence indicates not only that the two viruses were present in the same cells, but also that they multiplied in the same cells.

Experiments reported above gave no evidence of interference between tobacco mosaic and tobacco etch viruses, such as that reported between the severe strain of tobacco etch virus and potato Y virus (*1*). The interference phenomenon is well established for bacteriophages (*2*) and for certain viruses that cause disease in man and other animals (*3*, *8*). It has been demonstrated for plant viruses only in the case cited above. However, the literature on interference occasionally confuses this phenomenon with *cross protection* such as was observed by Kunkel (*5*) between tobacco and aucuba mosaic viruses. It seems worth while to point out here that cross protection, in contrast with interference, consists of the protection afforded a plant by virtue of a previous infection with a closely related virus strain. Nonrelated viruses do not ordinarily give such protection.

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Catheterization of the Coronary Sinus, Right Heart, and Other Viscera With A Modified Venous Catheter

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A technique of coronary sinus catheterization (*10*) has made it possible to study coronary blood flow and myocardial metabolism in intact dogs (6, 7, *11*) and has been recently applied to similar studies in man (*2*, *3*).[2] More recently a modified venous catheter has been devised to meet several of the special problems encountered in this procedure. In extensive trials in man, with Bing and his associates (*3*), as well as in dogs, the modified catheter described in this report appeared to facilitate catheterization of not only the coronary sinus, but also other regions in the heart and visceral veins.

The venous catheter now most generally used was designed by Cournand and Ranges (*4*), some years following Forssman's original description of right auricular catheterization in man (*8*). It is 100 cm long, of the ureteral type, with a woven shellacked nylon core covered with a heavy X-ray-opaque plastic coating and with a curved tip terminating in a single straight opening or "eye." (A catheter 125 cm in length is usually necessary for Dexter's technique of sampling blood from the pulmonary capillary bed *5*.)

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[2] The application of this technique, together with the nitrous oxide blood-flow method of Kety and Schmidt (*12*), to the measurement of coronary blood flow in man, has been a joint project undertaken by Bing and his co-workers at Johns Hopkins University Medical School, in cooperation with the authors and with Eckenhoff and his associates at the University of Pennsylvania Medical School (*5*). To all of these, the authors are deeply grateful for their collaboration and interest, and to Normal C. Jeckel and Edward W. Grant, of the U. S. Catheter and Instrument Corporation, for their help and advice.

Using this standard catheter, it has often been difficult to obtain blood samples from the coronary sinus and cardiac veins. Probably a vessel wall or valve leaflet has occluded the single terminal eye as suction has been applied with the sampling syringe, even though fluid could always be freely injected through the catheter. This difficulty was sometimes encountered in drawing blood from other regions, such as the hepatic or renal veins or the right ventricle, and was greater with smaller catheters (No. 6 to No. 8F). However, for avoiding coronary venous obstruction and possible intimal damage (*11*), these smaller catheters have been desirable. Pressure recordings have also been damped sometimes, apparently by the single terminal eye impinging upon a closely confining vessel wall or even upon the endocardial surface.

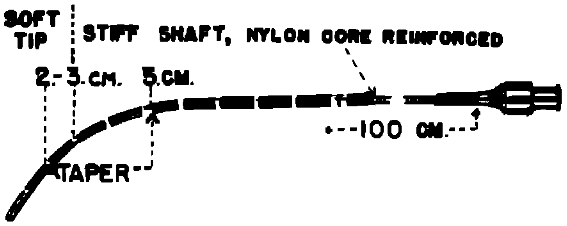

FIG. 1. Bird's-eye catheter (tapered).

The standard venous catheter of Cournand has, therefore, been modified by the addition of two small side eyes, or what we have termed "bird's-eyes," with shallow grooves in the outer surface of the catheter leading forward from the side eyes to the usual terminal eye (Fig. 1).[3] These features have prevented effective suction from being applied to a vessel wall, endocardium, or coronary-sinus valve leaflet during sampling, and no difficulties in withdrawing blood samples from any visceral vein have been encountered. Reasonable pressure recordings have been obtained which, if anything, have been less damped than those previously obtained in the right auricle and coronary venous system with the standard catheter. Any possible local trauma or cardiac arrhythmia arising from suction of intima or endocardium against the usual tip should also be minimized by the multiple eyes which break any suction against the modified catheter tip.

The "bird's-eyes" have been placed only 2 mm behind the tip, allowing accurate localization of blood samples and pressure recordings. The whole tip, including the grooves, has been given several extra coats of plastic finish to ensure a smooth atraumatic surface.

As a further modification, a tapered tip, also illustrated in Fig. 1, has proved valuable in catheterizing the hepatic and renal veins, as well as the coronary venous system of dogs and man (*9*). A No. 9F shaft with a gradual taper to a No. 7½F from a point 5 cm to 2 cm from the tip, or a No. 8F tapered to a No. 6½F tip, was found to be most advantageous. The nylon core has been doubly woven to a point 3 cm from the tip. This tapered catheter has combined the advantages of a relatively large, stiff, nonbuckling, easily manipulated, and easily visualized catheter shaft with a smaller, more flexible, less traumatic, and nonobstructing tip. This modification has facilitated controlled gentle insertion of the catheter into the coronary sinus. As an alternative, however, a No. 7 or No. 8F modified "bird's-eye" catheter without a taper has been used in man, often with a stylet inserted to within 3–4 cm of the tip to lend sufficient stiffness to the catheter shaft for controlled insertion (*3*). The stylet has then been removed as soon as the catheter had been successfully inserted into the coronary sinus.

The tapered catheter has a uniform No. 7 or No. 6F bore throughout its entire length, providing a minimal dead-space volume. Occurring at a known distance from the tip, the taper provided a landmark under fluoroscopy for direct estimation of the depth of insertion of the catheter into the coronary venous system.

Earlier workers were discouraged from using a catheter with side eyes or multiple eyes by the tendency for blood clots to form and obstruct the catheter lumen. With the present modified catheter this has been avoided by keeping the catheter thoroughly washed out with saline between samplings. A continuous saline infusion had to be maintained in addition to an injection of 5–10 cc of saline after each observation or sample. The grooves in the outer surface of the modified catheter tip prevented complete obstruction of either side eye by a vessel wall, so that the saline infusion constantly washed all 3 openings free of blood which might otherwise stagnate and clot. It was not necessary to add heparin to the continuous infusion, although several investigators add 20 mg/liter as an extra precaution against clotting. Others prefer to fill only the dead space of the catheter with the proper amount of heparin just before drawing each blood sample, so that the patient himself will receive no heparin. Traces of this heparin then appear to cling to the sides of the catheter lumen during the ensuing washout and sampling in sufficient quantity to prevent clotting until fresh saline infusion can be re-established. Tiny platelet thrombi were sometimes found in the side eyes after long procedures in man, but usually did not interfere with sampling.

In dogs, which have a more active clotting mechanism than man (*1*), an additional routine for preventing clotting in the catheter was often necessary (*11*). This might also be of value in man. The routine consisted of baking the catheter dry following the usual chemical sterilization and dipping the tip in full-strength heparin (Liquamine, Lilly) for an hour just before use. After proper drying the hydrophilic plastic coating absorbed enough heparin to act as an effective local surface anticoagulant.

Baking (at 110–120° C dry heat for 1–2 hrs) also stiffens the catheter, making it easier to manipulate accurately and probably less traumatically (*5*). Excessive heat (over 125° C) or too frequent baking shortens the life of the catheter. The only alternative to occasional baking, when the catheter finally becomes too limp to control, is the use of a stylet to lend sufficient stiffness for controlled insertion, as described above.

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[3] Available from the U. S. Catheter and Instrument Corporation, 334 Bay Street, Glens Falls, New York.

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A Modified Photoelectric Apparatus for Permeability Studies[1]

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For a number of years the author has been using a photoelectric technique for measuring the permeability of erythrocytes similar to that described by Parpart (*3*). Most of the experiments have involved hemolysis studies of chicken erythrocytes. Since the rate of hemolysis may be influenced by a number of different factors (e.g., Jacobs, *2*) it was decided to use swelling measurements only as an indication of permeability changes. The author has experienced much more difficulty in obtaining measurable light changes when chicken erythrocytes swell, however, than when mammalian erythrocytes are used.

It was thought that perhaps greater sensitivity could be obtained using light of a wave length corresponding to the region of the spectrum which is maximally absorbed by hemoglobin. Consequently, the light was passed through a green filter[2] before going through the erythrocyte suspension. This, however, decreased the light transmission to such an extent that the current produced by the photronic cell was too small to give a measurable deflection of the galvanometer. A photoelectric cell and amplifier were substituted for the photronic cell with satisfactory results. A photograph of the photocell-amplifier unit[3] is shown in Fig. 1 and a diagram of the circuit, in Fig. 2.

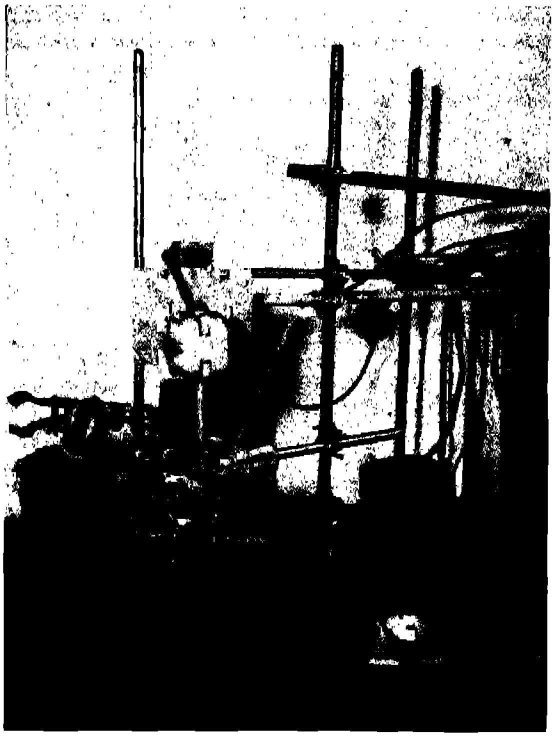

Fig. 1

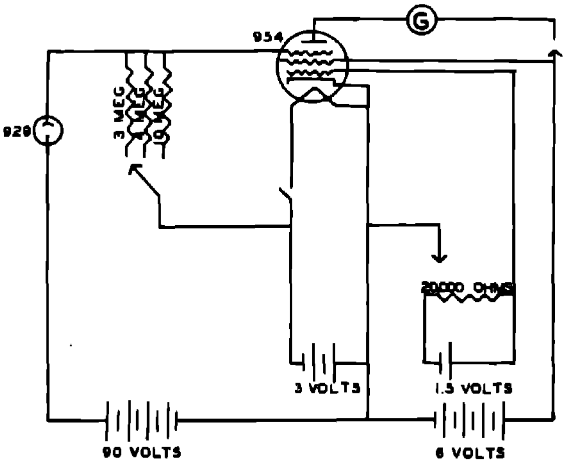

Fig. 2

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[1] This work was made possible by grants from the U. S. Public Health Service and from the Faculty Research Fund of the University of Oklahoma.

[2] Corning glass filter #4010, which has maximum transmission at 525 mμ.

[3] The author is indebted to Hans Weltin, Department of Physics, University of California, Santa Barbara, for the design and construction of this unit.

Much greater sensitivity and flexibility of the apparatus can be obtained without the green filter, using more concentrated erythrocyte suspensions. It can be seen from the circuit diagram that the amplifier has three degrees of sensitivity. In addition, an Ayrton shunt is placed in the galvanometer circuit which adds another means for varying the sensitivity.

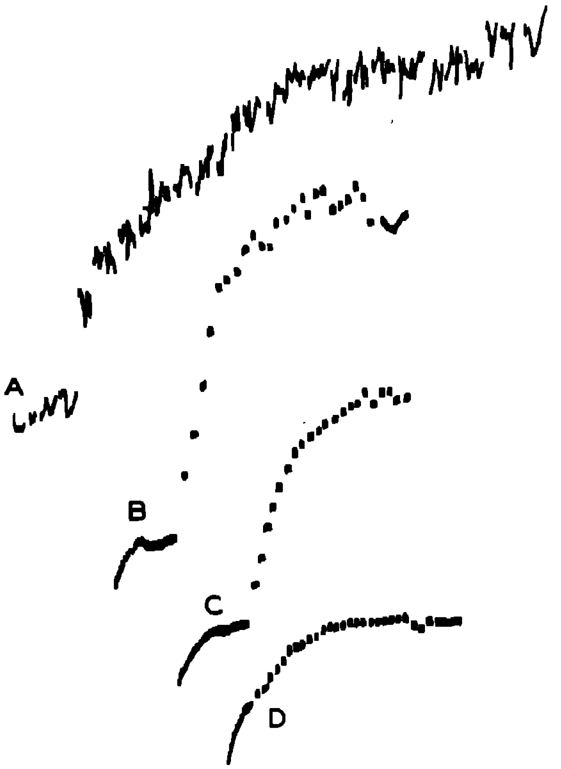

FIG. 3. The effect of concentration on swelling of chicken erythrocytes in 0.3 M glycerol in Ringer Locke. A—0.15 cc of blood; B—0.18 cc of blood; C—0.20 cc of blood; D—0.10 cc of blood (*medium sensitivity on amplifier*).

Figs. 3 and 4 illustrate the performance of the apparatus when used without the filter. In obtaining Figs. 3A, B, and C and 4B the shunt was set to give next to maximum sensitivity and the amplifier to give maximum sensitivity. Figures 3D and 4A were obtained with the shunt on next to maximum sensitivity and the amplifier on medium sensitivity. Figure 3 shows the effect of varying the concentration of chicken blood added to 10 cc of 0.3 M glycerol in Ringer Locke. The first 15 sec are recorded; readings were then taken at 15-sec intervals. In spite of the difference in deflection with the different concentrations, half of the total deflection in each instance is reached in approximately 1¼ min. Figure 4 is a continuous recording of the swelling of human erythrocytes in 0.3 M glycerol in Ringer Locke. In both A and B the deflection was too great to record the complete curve on the camera. A comparison between Figs. 3 and 4 demonstrates the greater galvanometer deflection which can be obtained using mammalian erythrocytes.

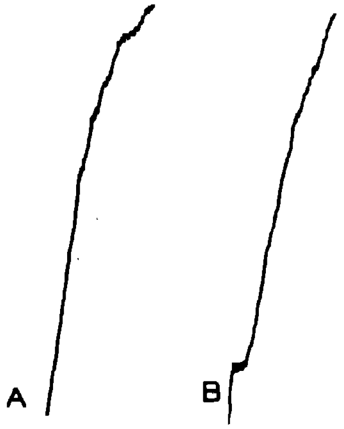

FIG. 4. The swelling of human erythrocytes in 0.3 M glycerol in Ringer Locke. A—0.06 cc of blood (medium sensitivity on amplifier); B—0.10 cc of blood (maximum sensitivity on amplifier).

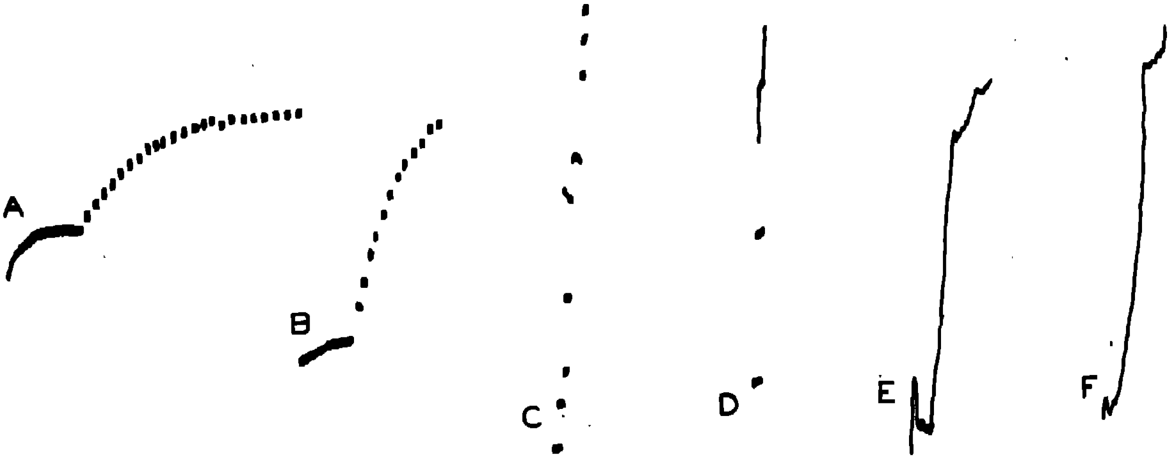

FIG. 5. The effect of standing at 37° C on the amount of galvanometer deflection obtained with chicken (A–D) and human (E, F) erythrocytes swelling in 0.3 M glycerol in Ringer Locke. A—0 hrs; B—3 hrs; C—6 hrs; D—19 hrs: E—½ hr; F—12 hrs.

Fig. 5 is included to illustrate a possible source of error which must be carefully considered in making measurements of swelling.[4] In a preliminary paper (*1*) it was pointed out that untreated chicken erythrocytes, after standing for several hours at 87° C hemolyze more rapidly than they do during the first few hours at this temperature. Fig. 5A–D illustrates that the galvanometer deflection increases as chicken erythrocytes stand at 37° C. At zero time the whole swelling curve can easily be recorded on the 12-cm bromide paper, but several hours later the deflection of the galvanometer becomes so much greater that only the first portion of the curve can be recorded. Figs. 5E and F show that no comparable change is observed when human erythrocytes stand at 37° C.[5]

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[4] Bacteriologically sterile techniques were observed except during the few minutes when the actual swelling measurements were made.

[5] All records were obtained using a recording camera placed 1 m from a Leeds and Northrop Type R galvanometer with a sensitivity of 0.003 µa/mm at 1 m and a period of .3 sec. A Kipp and Zonen torsion string galvanometer has also been used with satisfactory results. The temperature was 37° C in all cases. Figures 3–5 are tracings of the photographic records.

Comments and Communications

Blood Changes Due to Ammonia Inhalation?

We have read the recent article by Schmidt and Vallencourt entitled "Changes in the Blood Following Exposure to Gaseous Ammonia" (*Science*, November 19, p. 555). There are several serious errors apparent in this work which should be pointed out.

At the meeting of the American Public Health Association in Boston last November, we presented results of a study involving 30-min exposures of 7 human subjects to 500 ppm of anhydrous NH_3 gas. A description of the data was submitted for publication in October 1948 and will soon appear in a scientific journal.

A concentration of 500 ppm was used; therefore our results can be compared to those of Schmidt and Vallencourt. We selected ½-hr exposures since Henderson and Haggard (*Noxious gases*, New York: Reinhold, 1943, p. 126) reported that the maximum allowable concentration for a ½- to 1-hr exposure is 300 to 500 ppm.

All 7 subjects experienced irritation of the nose and throat immediately, and, in some, the irritation persisted for as much as 24 hrs. It is surprising that the subject reported in Schmidt and Vallencourt's paper did not experience marked irritation of the nose and throat after 4 hrs' exposure to a mean concentration of 545 ppm.

The authors failed to report the details of the exposure chamber and the subject's activity during the exposure. It seems unusual to maintain a gas concentration so well in an ordinary room unless the dilution rate is close to the rate of gas evolution. Since only two air analyses were made over a period of 4 hours and these were "grab samples" (L. Silverman, *Industrial air sampling and analysis*, Chem. and Tox. Bull. No. 1, Pittsburgh: Industrial Hygiene Foundation, 1947), it is quite possible that the actual concentration may have varied widely.

The values presented in the authors' Table 1 may be questioned in several respects. The most serious discrepancy appears to be in the blood-NH_3 (mg %) values (column 3). If one assumes a minute volume of 20 l[1] and an ammonia concentration of 545 ppm (mean of two determinations made by the authors) and, finally, that all ammonia is retained in a blood volume of 5 liters, then the values shown below are obtained. These results neglect ammonia conversion to other nitrogenous compounds and are presented below in comparison to the authors' values.

TABLE 1

Time (hrs)	Authors' NH_3 (mg %)	Calculated NH_3 (mg %)
Normal	00.0	00.0
1	12.1	8.7
2	21.9	17.4
3	27.9	26.2
4	36.4	34.9

From this table, it appears that the authors have found more ammonia than could theoretically be retained. Possible explanations might be either greater respiratory minute volume or lower blood volume, but these could hardly vary widely enough to explain the discrepancy. The invalidity of the assumption that all inhaled ammonia is retained is evident from our data, which show that the amount of ammonia retained decreases with time until after 30 min only 20 to 30% of the inhaled concentration is absorbed, as measured by frequent exhaled-air analyses. The data on blood ammonia presented by Schmidt and Vallencourt are rendered even more incredible by reference to Peters and Van Slyke (*Quantitative clinical chemistry* Vol. 1, 2nd ed. Baltimore: Williams and Wilkins, 1946). The method used was apparently not accurate enough to detect normal levels of blood ammonia, which, with proper methods, is of the order of 0.004 to 0.05 mg % (reported by Schmidt and Vallencourt: 00.0 mg %). It is well known that ammonia concentrations multiply rapidly in drawn blood unless rigid precautions are taken. On the other hand, the blood level *in vivo* is kept very near to 0 by the extraordinary efficiency with which ammonia is converted to amide nitrogen in the tissues and to urea in the liver. Ammonium salts are readily absorbed from the gastrointestinal tract; however, even large doses evoke but a slight transitory rise in blood ammonia, the ammonia being rapidly excreted as urea. Administration of 10 to

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[1] This represents the mean value of sedentary subjects exposed to 500 ppm in our study and represents the increase produced by NH_3 over normal values of 8–12 liters.

13 gms of ammonium citrate to normal human subjects raised the blood ammonia from 0.02 to 0.04 mg % to only 0.06 mg % (quoted by Peters and Van Slyke). Furthermore, ammonia is a highly toxic material. Bollman and Mann found that liverless dogs developed signs of ammonia intoxication (e.g. convulsions) when the blood level reached 2.0 mg % (*Amer. J. Physiol.*, 1930, 92, 92).

Our studies based on 30-min exposures indicated no significant deviations from normal in blood and urine nitrogen measurements.

Schmidt and Vallencourt state: "It has been known for some time that inhalation of ammonia lowered the blood pressure, but no quantitative data pertaining to this are available." Sollman (*A manual of pharmacology*, 5th ed. Philadelphia: W. B. Saunders, 1936, p. 837) states that the effect of ammonia inhalation is a rise of blood pressure, reflex in origin from stimulation of trigeminal nerve endings. Because of the reflex nature of the blood pressure effect and since our results showed that ammonia retention decreases with time, one would expect the influence of NH_3 on blood pressure to be greatest in the first 30 minutes. We found no consistent change at the concentration used, which agrees with the authors' finding, but it seems very unlikely that a later fall in blood pressure should be attributed to ammonia. Schmidt and Vallencourt are curiously indefinite on their "quantitative" observations of blood pressure. Whether the pressure reported is systolic or diastolic is not stated, and it is impossible to generalize about blood pressure responses from a single experiment on one individual. In view of the steady decrease in pressure shown by the authors for three hrs' exposure, it is curious that further observations were not made, since the decline at 3 hrs was approaching significantly hypotensive levels.

LESLIE SILVERMAN and JAMES L. WHITTENBERGER
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On New Nicotinolytic Compounds

In previous papers (C. Heymans and G. R. de Vleeschhouwer. *Arch. int. Pharmacodyn. Thér.*, 1948, 75, 307, 413) it has been demonstrated that the diethyl-amino-ethyl ester of phenyl-cyclopentane carbonic acid (parpanit) is a very active nicotinolytic agent. Intravenous injections of 20–30 mg/kg of parpanit indeed suppress all toxic actions of high doses of nicotine.

The present experiments were undertaken with another new synthetic compound: N-diethyl-amino-ethyl phenothiazine (diparcol). Some general pharmacological properties of this substance were already studied by Bovet, Fournel, and Charpentier (*Thérapie*, 1947, 2, 115) and Gordon (*Nature, Lond.*, 1948, 162, 140).

Our experiments (*Commun. Soc. Biol. Montevideo*, November 25, 1948) were performed on chloralosed dogs. Intravenous injections of 15–30 mg/kg of diparcol protect completely against 100–200 lethal doses of nicotine. No cardiac slowing or irregularities, cardiac fibrillation, changes in blood pressure, bronchospasms, hyperperistalsis, convulsions or muscular fibrillations, salivation, or paralysis of the respiratory center occurs after intravenous injections of 100–200 LD of nicotine in dogs pretreated with diparcol. Thus, this new compound is also a very active nicotinolytic agent.

Parpanit and diparcol are not only powerful nicotinolytic substances but also synapticolytic, parasympatholytic and anticonvulsant agents. These compounds also very actively protect against high doses of acetylcholine, pilocarpine, diisopropyl fluorophosphate (DFP), strychnine, and Metrazol.

These experimental observations may have some important practical applications.

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University of Montevideo, Uruguay

Nazi Persecution of Scientists

In connection with Professor Muller's letter to the Soviet Academy of Sciences (*Science*, October 22, p. 436), I think it would be helpful to call the attention of every American scientist, Army and Navy officer, and congressman, to a few sentences in *Goebbels' diaries* (New York: Doubleday, 1948).

On page 361 Goebbels tells of an occasion on which he, Frick, and Rust were guests of the Fuehrer. He wrote, "Their comments and remarks were so idiotic as to reveal how completely out of the picture they really are. They delivered themselves of stupid phrases . . . ." The important point is that Rust was the Nazi Minister of Education and, as Lochner notes, he had been an inmate of an insane asylum! He was the one chosen to persecute the scientists and university leaders, causing them to flee from Germany for their lives.

This seemed to be a good idea at first, but on May 12, 1943, things were going badly for the Germans in the air and on the sea. The Allies were using new discoveries in physics which were paralyzing the German planes and submarines. And so, on p. 375, one finds Goebbels regretting that Max Planck had been so antagonized. As he said, "It is the fault of Rust and is irremediable . . . . The mediocre talents in the Reich Government are a wall between the Fuehrer and many sectors of public life." In his devotion to his Fuehrer, Goebbels tried to make him out as a would-be patron of science, ignoring the fact that he had appointed a miserable quack as his private physician.

On p. 378, speaking of the critical situation of the submarines in the face of the new detecting devices developed by Allied physicists, Goebbels wrote, "Our technical development both in the realm of submarines and of air war is far inferior to that of the English and the Americans. We are now getting the reward for our poor leadership on the scientific front, which did not show the necessary initiative to stimulate the willingness of scientists to co-operate. You just can't let an absolute nitwit head German science for years and not expect to be punished for such folly."

This paragraph might well be read and re-read now at home and abroad. In times of peace, baiting scientists and great men and putting them in their place is great fun for politicians but Goebbels has told us how disastrously this policy pays off when war comes.

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Book Reviews

Methods of psychology. T. G. Andrews. (Ed.) New York: John Wiley; London: Chapman and Hall, 1948. Pp. xiv + 716. (Illustrated.) $5.00.

Many instructors have long desired a systematic text to facilitate greater emphasis on methodology in the training of undergraduate psychology students. This book, which deals with methodology in many areas of psychology, was written by specialists in each area. The editor recognizes certain limitations in terms of omissions, both in the material presented and in areas not represented, such as industrial psychology.

After an introductory chapter on variables, controls, experimental design and the like, methodology in each of several areas is presented. Consideration is given to various aspects of learning, psychophysics, perception in various sense modalities, affection, motor functions, personality, social behavior, child development and others.

The things an instructor might like to find in the discussion of any one area, such as studying human thinking, might well include the following: sample problems, experimental designs for the problems, outlines of methods with apparatus including diagrams and controls, references to more complete details in published reports, methods of treating data with sample tabular arrangements and graphs, and some guidance for critical interpretation of results. No chapter of this book may completely satisfy all the requirements laid down by the critical reader. Some are very well done but others are poor in terms of adequate treatment of methods in the area. For instance, the reviewer considers the discussions of "Psychophysical Methods," "Studying Proprioception," "Motivation, Feeling and Emotion," and "Studying Neuropsychology and Bodily Functions" to be among the better chapters. "Studying Vision," on the other hand, is poor and some of the other sections are only mediocre. The first chapter, on introduction to psychological methodology, could have been more complete in details and illustrations.

There are two major deficiencies in the organization of this treatise: the apparent expectation that the meagre information on experimental design and controls in the first section will transfer to the study of subsequent chapters, and the attempt in most chapters to cover too much territory, which obviously has led too frequently to skimpy treatment of experimental design, methods, apparatus, and controls. In terms of teaching methodology, the book might have been more helpful to the student if each chapter had included brief statements of types of problems and methods with references to sources where complete descriptions may be found. Then there should have been a discussion of one typical experiment including a statement of the problem, method and apparatus with experimental design, controls, organization of results and conclusions. With the present organization of the book, it is doubtful if the student will learn the requirements for planning and carrying out experimental work in more than a few of the areas.

This text, which has several excellent chapters, represents a step in the proper direction. Criticism of the materials presented undoubtedly will eventually lead to a revision with a better organization. In the meantime the book should find general use in experimental and methodology courses.

MILES A. TINKER

University of Minnesota

Principles of mathematical physics. (2nd ed.) William V. Houston. New York-London: McGraw-Hill, 1948. Pp. xii + 363. $5.00.

The first edition of Houston's book was known to teachers of theoretical physics for the clarity of its presentation and the judicious selection of material included. The second edition preserves these advantages. It is still a textbook usable in an intensive semester or a leisurely year's course, although it has been expanded and rearranged. The problems continue to be a major feature of the text and these are not routine but form a complement to the material chosen for detailed treatment. Especially useful, and rarely found in books of this type, is a chapter on the theory of vibrating systems.

It might be said that the work is incomplete and lacks coherence. If the size of the book was set in advance, however, the author has utilized the space for the most worthwhile material.

HENRY MARGENAU

Yale University

Studies of upper-air conditions in low latitudes. Part I: ***On the formation of West Atlantic hurricanes*** (Riehl); Part II: ***Relations between high- and low-latitude circulations*** (Cressman). Herbert Riehl and George P. Cressman. Chicago: Univ. of Chicago Press, 1948. Pp. vi + 103. (Illustrated.) $2.00.

Military requirements during World War II and certain unsolved problems of the general circulation in the earth's atmosphere have been a stimulus to a considerable amount of research in tropical meteorology during the past several years. Successful research in this field of meteorology requires an unusually high degree of skill in analysis and interpretation because of the vastness of the geographical region under consideration, the paucity of the available data, and the complexity of the phenomena under study. The authors have been prominently associated with recent research in this field, and their report, though plainly not a comprehensive summary of knowledge concerning tropical meteorology, clarifies several important aspects of low-latitude weather, emphasizes the importance of upper air analysis, and stresses the interrelationship between tropical weather phenomena and extratropical circulation patterns.

In Part I the structure of tropical hurricanes is compared with the less spectacular, but climatologically more significant, tropical disturbances, and the circumstances attendant upon the transition from one to the other are discussed. An explanation for the generation of cyclonic vorticity is presented which differs from that usually accepted in middle latitudes. The importance of an overlapping between middle- and low-latitude disturbances is discussed and illustrated with synoptic examples.

Part II is restricted to the definition, description, and illustration of typical circulation patterns during the summer months. The importance of the interrelation between tropical and extratropical disturbances is discussed.

The report is an excellent example of the results which can be obtained in a highly specialized field by research scientists who are thoroughly familiar with current and past research in other fields of meteorology.

Thomas F. Malone
Massachusetts Institute of Technology

Scientific Book Register

Condit, Ira J. *The fig.* Waltham, Mass.: Chronica Botanica; New York: Stechert-Hafner, 1947. Pp. xv + 222. (Illustrated.) $5.00.

Corner, George W. (Ed.) *The autobiography of Benjamin Rush: his "Travels Through Life" together with his Commonplace Book for 1789–1813.* Princeton, N. J.: Princeton Univ. Press, 1948. Pp. 399. (Illustrated.) $6.00.

Curtis, Winterton C., and Guthrie, Mary J. *Laboratory directions in general zoology.* (4th ed.) New York: John Wiley; London: Chapman & Hall, 1948. Pp. viii + 236. (Illustrated.) $2.00.

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Elliott, Godfrey M. (Ed.). *Film and education: A symposium on the role of the film in the field of education.* New York: Philosophical Library, 1948. Pp. xi + 597. $7.50.

Field, Henry. (Compiler.) *Contributions to the anthropology of the Soviet Union.* (Publ. 3947.) Washington, D. C.: Smithsonian Institution, 1948. Pp. vii + 244. (Illustrated.) $2.00.

Kelley, Walter P. *Cation exchange in soils.* New York: Reinhold, 1948. Pp. xv + 144. (Illustrated.) $4.50.

Marton, L. (Ed.). *Advances in electronics.* (Vol. 1.) New York: Academic Press, 1948. Pp. xi + 475. (Illustrated.) $9.00.

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Association Affairs

AAAS Staff Changes

Science regrets to announce the resignation on December 31 of Executive Editor Mildred Atwood Rustigan. Her capacity for hard work and her editorial and administrative ability have been of the highest value at all times during her association with the AAAS editorial staff, and really essential to the publication of *Science* since the untimely passing of the editor, Dr. Willard L. Valentine, in 1947. Miss June Armstrong, who has been associated with Mrs. Rustigan in editorial duties on *Science* and who is now serving as acting executive editor, has resigned effective February 28 to return to the Pacific Coast.

Beginning with the present issue Miss Beth Wilson becomes executive editor of *Science*. Miss Wilson has been assistant editor of *Physics Today* and had previously worked for *Fortune* and *Science Illustrated*. She is a graduate of the University of Nebraska, and a member of Phi Beta Kappa. The *Science* staff also includes Miss Dorothy Witham, Miss Jeanne Hopson, Mrs. Arlene Butterly, and Mrs. Anna H. Freedman.

Dr. F. R. Moulton retired as administrative secretary at the close of his term, January 15. His great services to American science through AAAS activities will be the subject of a later article in *Science*. As announced in the issue of November 26, 1948, Prof. Howard A. Meyerhoff is assuming the position of administrative secretary of AAAS. Until the end of the present academic year, he will also be engaged as professor of geology at Smith College.

Sincere regret is felt at the resignation on December 31, of Dr. John M. Hutzel, assistant administrative secretary, to accept an important post in government service. He will continue to serve the Association as administrative consultant. Effective February 1, 1949, the position of assistant administrative secretary will be filled by Prof. Raymond L. Taylor of Sampson College, formerly of the College of William and Mary.

Conference on U. N.

On January 14 the AAAS was officially represented by Howard A. Meyerhoff at a National Conference on the United Nations, called by the Department of State. The invitation was issued by Francis H. Russell, Director of the Office of Public Affairs, and the Executive Committee responded at its December meeting by naming as its representative the Administrative Secretary and, as an alternate, the President, E. C. Stakman. The crowded program was a successful effort to place before the 200 people in attendance the facts of diplomatic life in one vital field of U. S. international relations.

The program, which occupied a very full day, started at 9:00 A.M. with a general session of the conference, held in the State Department Auditorium. Chairman Francis H. Russell opened the conference and Acting Secretary of State Robert A. Lovett made introductory remarks. Dean Rusk, Director of the Office of United Nations Affairs, spoke on "Regional Security Arrangements Under the United Nations Charter"; Mrs. Franklin D. Roosevelt, U. S. Delegate to the General Assembly, on "Developments on Human Rights at the Paris Meeting of the General Assembly"; and Durward V. Sandifer, Deputy Director of the Office of United Nations Affairs, on "Next Steps in the United Nations Human Rights Program." At 11:30 conference members took part in round table discussions on human rights.

The luncheon meeting at the Hotel Washington was addressed by Howland W. Sargeant, Deputy Assistant Secretary of State for Public Affairs, and by John Foster Dulles, U. S. Delegate to the U. N. General Assembly, who reported on the Paris session of the General Assembly.

The mid-afternoon general session, at which Willard L. Thorp, Assistant Secretary of State for Economic Affairs, spoke on "Major Items on the Agenda of the Economic and Social Council," was followed by more round table discussions—on economic and social problems of the U. N. and regional security arrangements. The five o'clock general session was devoted to reports of the various round table discussions and the conference adjourned at 5:30 after closing remarks by the Chairman.

The conference was the first of a series of three, the purpose of which, although allegedly to provide opportunities for leading organizations concerned with international affairs "to assist in the constructive efforts of your Government toward solving the problems facing the United Nations," appears to be the frank dissemination of knowledge as to what is transpiring in the U. N. The entire meeting was refreshingly free from anything resembling propaganda. Although many of the subjects discussed lie on the periphery of science, the social and economic problems considered, in addition to being everyone's concern, have important scientific connotations. It was evidently for this reason that the 150 organizations represented at the conference included such diversified groups as the AAAS, Kiwanis International, National Association for the Advancement of Colored People, National Catholic Education Association, Railway Labor Executive Association, American Federation of Labor, Engineers Joint Council, and Church of Jesus Christ of Latter-Day Saints.

A second conference will take place in March, to consider the entire range of U. S. foreign policy; and a third, on the economic and social programs of the United Nations, is scheduled for May. The Association plans to have representation at both these meetings. (HOWARD A. MEYERHOFF, *Administrative Secretary*.)

NEWS and Notes

John S. Laughlin, who has been working on the betatron project at the University of Illinois Chicago Professional Colleges, has been appointed assistant professor of radiology and radiation physicist at the University's College of Medicine.

John H. Payne has been appointed head of the Technology Department of the Hawaiian Sugar Planters' Association Experiment Station, Honolulu.

Tracy M. Sonneborn, professor of zoology, Indiana University, will deliver the fifth Harvey Lecture of the current series at the New York Academy of Medicine on February 17. Dr. Sonneborn will speak on "Cellular Transformations."

S. Smith Stevens has been appointed director of the Harvard Psychological Laboratories, succeeding **Edwin G. Boring**, who is resigning his directorship after 25 years of service but will continue as professor of psychology.

Margery C. Carlson, assistant professor of botany at Northwestern University, is making a six-month botanical exploration of Mexico and Central America. Dr. Carlson will collect specimens of the native flora to be deposited in the Chicago Natural History Museum. The expedition is sponsored jointly by the Museum and the University.

Lawrence R. Hafstad, former executive secretary of the Joint Research and Development Board of the National Military Establishment, has been appointed director of the new Reactor Development Division of the U. S. Atomic Energy Commission. This division of the USAEC was created last August to carry out the program of designing and developing nuclear reactors for the practical application of atomic energy for power, propulsion of ships and aircraft, production of isotopes, and for research on reactors themselves.

George W. Schaeffer, former assistant professor of chemistry at the University of Chicago, has been appointed associate professor and director of the Department of Chemistry at Saint Louis University.

David E. Lilienthal, chairman of the U. S. Atomic Energy Commission, will deliver the mid-year commencement address and receive the honorary degree of doctor of laws at Lehigh University, February 6.

J. Lanjouw, conservator of the Herbarium and Botanical Museum at the University of Utrecht, Netherlands, has been appointed professor of plant taxonomy, succeeding A. A. Pulle, retired. Dr. Lanjouw is at present in Surinam doing botanical work.

Shepard Bartnoff and **Winston H. Bostick** have been appointed instructors in physics at Tufts College.

Merritt L. Fernald, retired director of the Gray Herbarium of Harvard University, and Fisher professor emeritus of natural history, has been elected to the Royal Society of Sciences of Uppsala.

Robert R. Sears of the University of Iowa has been appointed professor of education and child psychology at Harvard University. Dr. Sears will also become director of a new laboratory of human development to promote research in the fields of motivation and learning theory.

Ford M. Milam of the University of West Virginia is now employed by the U. S. Department of Agriculture as head of the agronomy department at its experiment station in San Salvador, El Salvador, Central America.

Paul Magnus Gross, professor of chemistry at Duke University, has been elected vice president of the University in charge of the educational division. Dr. Gross is also dean of the Graduate School at Duke.

Raymond Kennedy, professor of sociology at Yale University, will leave in June to spend 15 months in Indonesia studying the influence of western civilization on native culture. The Indonesian research trip is a project of the Southeastern Asia Studies, whose headquarters in this country are at Yale. The trip will be supported by the Viking Fund, the Coolidge Fund, and the Social Science Research Council.

Grants and Awards

John Rawlings Rees, British scientist and president of the World Federation for Mental Health, has received an award of $5,000 from the International Committee for Mental Hygiene in New York, for his research into the application of psychology to international relations.

Two German scientists are to receive Nobel prizes in chemistry that Hitler had forbidden them to accept. They are Richard Kuhn of Heidelberg University, who won the prize in 1938, and A. Butenandt of Tuebingen University, who won it in 1939.

The Carl Neuberg Medal for 1949 has been awarded to F. F. Nord of the Chemistry Department of Fordham University.

Warren K. Lewis, professor emeritus of chemical engineering at the Massachusetts Institute of Technology, will be awarded the 1949 gold medal of the American Institute of Chemists at the Institute's annual meeting in Chicago in May.

Smith, Kline and French Laboratories of Philadelphia have awarded a total of 73 grants amounting to $314,761 in support of medical research during 1948. The funds provide for scholarships and fellowships, aids to preclinical research, and support of investigations in fields of clinical medicine. Twenty-seven of the grants were made to medical schools, and the balance to institutes, clinics, and individual investigators.

Mathematicians Donald C. Spencer, Stanford University, and Albert Schaeffer, Purdue University, have been named joint recipients of the **Bocher Memorial Prize**, which is awarded every five years by the American Mathematical Society. The prize is $100, and each received this amount. They were honored for their book on conformal mapping, a technical mathematical work of which one application is in computation of pressures in the flow of air over an airplane wing.

Fellowships

Duke University School of Medicine will make available on July 1 several two-year fellowships carrying stipends of $2,400 the first year and $3,000 the second year. The work will include special training, clinical and consultation practice, and teaching and research in the fields of hematology and allergy, pulmonary diseases, gastro-enterology, hypertensive cardiovascular and renal diseases, metabolic diseases, cardiology, and general internal medicine and therapeutics. Applicants must have completed three years of training in internal medicine or a satisfactory equivalent. Further information may be obtained from Eugene A. Stead, Jr., Professor of Medicine, Duke University School of Medicine, Durham, North Carolina.

The Conway MacMillan Memorial Research Fellowship in Botany at the University of Minnesota is offered again to doctoral students for the year 1949–50. The award of $1,200 for the academic year is supplemented by payment of tuition fees in the Graduate School. Applications must be made by *March 1*. Address all inquiries to A. O. Dahl, Chairman of the Conway MacMillan Fellowship Committee, Department of Botany, University of Minnesota, Minneapolis 14, Minnesota.

Colleges and Universities

The Damon Runyon Laboratory of Chemical Embryology of the University of Colorado Medical Center will be housed in a new cancer research wing to be constructed at the Center through funds recently made available by the National Cancer Institute of the U. S. Public Health Service and the University of Colorado. The grant of $25,000 received last summer from the Damon Runyon Cancer Fund will be administered by representatives from the Departments of Biochemistry, Obstetrics and Gynecology, and Pediatrics. The Laboratory will be directed by Heinz Herrmann, now at Yale University and formerly at the Biological Institute of the Carlsberg Foundation, Copenhagen. He will join the staff as associate professor of pediatrics (research) on July 1, 1949.

Providence College, Providence, Rhode Island, dedicated its Albertus Magnus Science Hall on January 27–29. The new millon-dollar building will house the Departments of Biology, Chemistry and Physics.

The Building Committee of the **University of Texas Medical Branch,** Galveston, under the chairmanship of W. B. Sharp, professor of bacteriology, reports plans for new buildings at the Medical Branch to cost more than $6,000,000. These include part of a new general hospital and a private pavilion to be erected by the Sealy and Smith Foundation at an estimated cost of $3,500,000 and the Henry and Ross Zeigler Tuberculosis Hospital, to be built by funds from the Zeigler bequest.

The 2nd Symposium on Plasticity will be held at **Brown University** April 4–6, 1949, under the sponsorship of the Bureau of Ships and the Office of Naval Research, Navy Department. The principal topics will be "Structural Applications of the Theory of Plasticity" and "Dynamic Problems of Plasticity." One day will be devoted to miscellaneous contributions to theoretical or experimental phases of plasticity. Further information may be obtained from Prof. P. S. Symonds, Graduate Division of Applied Mathematics, Brown University, Providence 12, Rhode Island.

The 30-inch Jenkintown, Pennsylvania telescope, one of the 50 largest reflectors in the world, has been purchased by the **Agnes Scott College,** Decatur, Georgia.

The Fritz Engineering Laboratory of **Lehigh University** has been assigned a two-year research project aimed at checking and improving design procedures of shell roof structures of the type used in large airplane hangars and in the domes of monumental buildings. The assignment was made by the Roberts and Schaefer Engineering Company of Chicago.

The recently established Harvard Foundation for Advanced Study and Research, designed to further the interest of the Schools of Arts and Sciences, Design, Education, Engineering, and Public Administration, will provide for student housing, research, fellowships, and scholarships in the areas of graduate study encompassed by the schools. In addition to the five graduate schools, a number of non-tuition-paying University departments will participate in the Foundation. These include the Arnold Arboretum, Atkins Garden and Research Laboratory, Blue Hill Meteorological Observatory, and the following museums: Botanical, Comparative Zoology, William Hays Fogg, Germanic, Peabody, and Semitic.

Summer Programs

The Institute of Statistics of the University of North Carolina, Chapel Hill, will offer a summer session from June 9 to July 19 for research workers in other sciences who want a practical working knowledge of statistical theory, statistical consultants in various fields, those preparing to teach statistics or develop statistical theory, and students working toward a degree in applied or theoretical statistics. An announcement of the course may be obtained from the Director, Institute of Statistics, University of North Carolina, Box 168, Chapel Hill, North Carolina.

The Mount Desert Island Biological Laboratory, Salsbury Cove, Maine, will continue its tissue culture program this year June 15–September 15. Accommodations are available for about 10 investigators with research problems in the field of aseptic cultivation of tissues, organs, and embryos of plants and animals, with preference given to projects utilizing local organisms. Only applicants qualified to carry on independent research will be accepted. Applications should be sent before March 15 to Dr. Philip R. White, Institute for Cancer Research, Corinthian Avenue and Poplar Street, Philadelphia 30.

Duke University School of Medicine and Duke Hospital, Durham, North Carolina, will offer a course in medical mycology under the direction of Norman F. Conant this summer. The course will emphasize the practical aspects of the laboratory as an aid in helping establish a diagnosis of fungus infection. Classes will be held every day in the week except Sunday during the month of July. A fee of $50 will be charged for the course and a certificate will be awarded upon completion. Further information may be obtained from Dr. Norman F. Conant, Duke University School of Medicine.

Industrial Laboratories

The problems of research and engineering involved in improving the chemical processes of plutonium production have been assigned to the **E. I. duPont de Nemours and Company** by the U. S. Atomic Energy Commission. The survey will include study of means to increase the amount of plutonium produced from a given quantity of uranium and ways to simplify the handling of the wastes of the production process.

Production of water-white single crystals of pure calcium tungstate in research quantities has been announced by the **Linde Air Products Company**, Unit of Union Carbide and Carbon Corporation. Two of their major uses, as indicated by the Company, are in scintillation counters in the detection and measurement of radioactivity, and as screens in X-ray fluoroscopy.

The Multi-Tron Laboratory of Chicago has been established to conduct research and development in the fields of electronics, radiation, optics, and nuclear physics, with special emphasis on high and low voltage electronic tubes.

Westinghouse Electric Corporation has named William E. Shoupp and Robert A. Bowman to direct the research and engineering respectively of its new Atomic Power Division. Dr. Shoupp is the former manager of electronics and nuclear physics research at the Westinghouse Research Laboratories in Pittsburgh, and Dr. Bowman the former manager of condenser engineering at the Company's Steam Division in South Philadelphia. The Division's activities will include construction and testing of an atomic power plant for the propulsion of naval vessels.

John W. Coltman has been appointed manager of the electronics and nuclear physics department of the **Westinghouse Research Laboratories.** Dr. Coltman, former head of the X-ray section, succeeds **William E. Shoupp**, who was recently named director of research for the Westinghouse atomic power division.

Meetings and Elections

The Seventh Pacific Science Congress will be held in Auckland and Christchurch, New Zealand during the month of February. It is expected that 30 countries interested in Pacific problems will be represented at the Congress, which plans for meetings covering geology, geophysics, meteorology, oceanography and marine biology, zoology, botany, soil resources, forestry, agriculture, anthropology, public health, nutrition, and the social sciences. Seventy-one American scientists are planning to participate in the program, some of whom will stop over in American Samoa to consult with those engaged in scientific research there.

The Ohio Alpha Chapter of Alpha Epsilon Delta, national premedical society, will be host for a state-wide convention of premedical students, advisors, and faculty members of all the liberal arts colleges in the state at the Ohio State University, Columbus, on February 19.

The annual **Louisiana State University Symposium on Modern Methods of Analytical Chemistry** will be held March 2–5 in Baton Rouge. A formal program of lectures and round table discussions has been planned. Hotel reservations should be made as soon as possible by writing: Dr. Philip W. West, Coates Chemical Laboratory, Louisiana State University, Baton Rouge 3, Louisiana.

The Optical Society of America will hold its winter meeting in New York City March 10–12. Headquarters will be the Hotel Statler (formerly Hotel Pennsylvania). The meeting will be open to non-members of the Society.

The American Chemical Society will hold its 115th national meeting in San Francisco March 28–April 1. Air pollution, the cause and treatment of high blood pressure, and chemical aspects of heredity and mutations are among the subjects to be discussed.

The 2nd National Symposium on Recent Advances in Antibiotics Research, sponsored by the Antibiotics Study Section of the National Institutes of Health to stimulate research in this field, will be held in Washington, D. C., on April 11–12. All interested persons may not only attend the meetings but also participate in the proceedings by presenting reports of current investigations in the field. Only papers concerned with original and unpublished observations can be considered, however. It is hoped that all accepted papers can be published as a single monograph or as a supplement by one of the scientific journals. All abstracts of papers (in triplicate) should be sent to Dr. Leonard Karel, Executive Secretary, Antibiotics Study Section, Division of Research Grants and Fellowships, National Institutes of Health, Bethesda, Maryland, before March 10.

The Mathematical Association of America elected the following officers at its annual meeting in December: president, R. E. Langer, University of Wisconsin; second vice president, N. H. McCoy, Smith College; members of the board of governors: C. B. Allendoerfer, Haverford College and R. J. Walker, Cornell University. Continuing in office from last year are Saunders MacLane, University of Chicago, first vice president, and H. M. Gehman, University of Buffalo, secretary-treasurer. Dates were set for 1949 meetings: June 20–21, a joint meeting with the American Society for Engineering Education at Rensselaer Polytechnic Institute, Troy, New York; August 29–30, the 31st summer meeting, at the University of Colorado, Boulder, Colorado; December 30, the 33rd annual meeting, in New York City.

The Pacific Chemical Exposition is scheduled for November 1–5 at the San Francisco Civic Auditorium. James O. Clayton, research associate of the California Research Corporation has been appointed chairman.

At the 18th annual meeting of the **Western Society of Naturalists**, held at Occidental College, Los Angeles, December 28–30, 1948, officers were elected as follows: **President, Richard M. Eakin, Department of Zoology, University of California, Berkeley;** vice-president, Lyman Benson, Department of Botany, Pomona College; secretary-treasurer, William M. Hiesey, Division of Plant Biology, Carnegie Institution of Washington, Stanford; members at large on the executive committee, Margaret H. Storey, Natural History Museum, Stanford University, and F. M. Scott, Department of Botany, University of California, Los Angeles.

The American Microscopical Society, at its recent annual meeting held in Washington, D. C., elected the following officers for 1949: Clarence E. Taft, president; Irene McCulloch, first vice president; David C. Chandler, second vice president; Frank E. Eggleton, secretary-editor; Alden B. Dawson, elective member of the executive committee.

The Hawaii Psychological Association, recently formed by a group of fellows and associates of the American Psychological Association in Hawaii, elected the following officers for 1949: president, Theodore W. Forbes; president-elect, Colin J. Herrick, secretary-treasurer, Helen E. Peixotto; representative to the APA, W. Edgar Vinacke; and representative at large to the executive council, Mildred C. Mendenhall.

The American Academy of Dental Medicine will hold its annual meeting June 4–5 at the Statler Hotel in New York City. One feature of this year's program will be a symposium and round table discussion on psychomatics. Further information can be obtained from Dr. William M. Greenhut, National Secretary, 124 East 84th Street, New York City 28.

Deaths

Gertrud Oppenheimer, 55, German chemist who had been at the California Institute of Technology since 1942, died August 27, 1948, in an automobile accident.

Ryozo Kanehira, Japanese forester and botanist, died in Tokyo on November 27. From 1942–1945, Dr. Kanehira served as director of the library and herbarium at Butienzorg, Java, and was instrumental in making living conditions for the interned scientists more satisfactory there. Later, he became technical consultant in forestry to the Natural Resources Section, G.H.Q., Tokyo.

Adolph R. Ringoen, 62, a member of the Department of Zoology of the University of Minnesota for the past 36 years, died January 13 in Minneapolis.

James F. McKernon, 83, professor of otology, who was president of the New York Post-Graduate Medical School and Hospital for 14 of his 26 years' service there, died January 23 at his New York City home.

Tenney L. Davis, 59, professor emeritus of organic chemistry at M. I. T. and former secretary of the American Academy of Arts and Sciences, died January 25 in Norwell, Massachusetts. Upon retiring from the M. I. T. staff in 1942, Dr. Davis became director of scientific research for the National Fireworks Company of Hanover, Massachusetts.

Lithium deuteride and lithium aluminum deuteride are now being synthesized by Metal Hydrides, Inc. and can be purchased from this source at cost by research organizations having need for the material. Information regarding price and availability may be secured from Metal Hydrides, Inc., 12–24 Congress Street, Beverly, Massachusetts. Blanks (AEC Form 100) for obtaining the necessary approval from the AEC will be sent on request by the Company or the Isotopes Division, USAEC, P. O. Box E, Oak Ridge Operations, Oak Ridge, Tennessee.

A new lightweight film-cassette changer for taking stereoscopic views of the human chest has been developed for military field use by the Engineering Development Division of the Army-Navy Medical Procurement Office at its Fort Totten, New York laboratories. The new apparatus weighs only 75 pounds, as compared with currently available models ranging from 370–700 pounds, and has a volume of only 4.6 cubic feet. Lightweight construction has been attained by the elimination of heavy counterweights and by the use of lighter metals, principally aluminum.

Veterinarians are needed by the Bureau of Animal Industry of the U. S. Department of Agriculture for work in such fields as Federal meat inspection and research, in the control of animal diseases. Graduates of recognized veterinary colleges who are interested may obtain further details by writing to the Bureau of Animal Industry, Agricultural Research Administration, U. S. Department of Agriculture, Washington 25, D. C.

A previously uncharted natural arch of white sandstone in southern Utah has been named Grosvenor Arch in honor of Gilbert Grosvenor, president of the National Geographic Society, by Jack Breed, Boston naturalist who discovered it during his Escalante Expedition from Bryce Canyon last summer. The arch thrusts eastward from a massive ridge and towers 152 feet above the valley floor. The underside of the main arch is 139 feet high, but the opening is worn only part of the way down, being 40 feet wide and 73 feet high. A second opening, 6 feet high and 4 feet wide, is close to the top and creates a double arch effect.

The Florida Academy of Science has completed the first 10 volumes of its *Quarterly Journal*. The Academy has attempted to include in the publication as little on its own business and as much original research material as possible. Papers are accepted entirely on merit.

Southwest Research Institute, the Institute of Inventive Research, and the **Foundation of Applied Research** have announced the following new appointments to their technical staffs: to SWRI, Charles E. Balleisen, Duffer B. Crawford, Dean Hawley, Maurice Holland, Leopoldo H. Mayoral, Gilbert D. McCann, Apolonio L. Morales, Ray Neumann, Norman C. Penfold, Kenneth Shaftan, Erwin R. Strong, Jr., and Judson S. Swearingen; to IIR, Ion Edeleanu; and to FAR, Wayne A. Kalenich, Travis S. Richardson, and Raymond Umbaugh.

The Philadelphia Section of the American Chemical Society will sponsor two special noncredit courses on sulfur chemistry and on process control, each of which will be offered on ten successive Monday evenings, beginning February 21. The Section has also arranged a series of lectures on the administration of industrial research, which will be presented on Tuesday evenings. The classes will be open to both members and nonmembers of the Society and will be located in the Philadelphia College of Pharmacy and Science, 43rd and Kingsessing Avenue, Philadelphia. Further information may be obtained from Dr. J. F. Gall, Whitemarsh Research Laboratories, Pennsylvania Salt Manufacturing Company, Wyndmoor, Pennsylvania.

Fossil remains of fish and plants of the Upper Triassic period (175,000,000 years ago) are being excavated near Haymarket, Virginia by David H. Dunkle, Smithsonian Institution paleontologist. The fish, which presumably lived in a fresh-water lake, were ancient forms of bony fishes whose extant descendants are the gar pike and the bow fin, or fresh-water dogfish. The ancient forms were hitherto poorly known in this region, although they are similar to those commonly found in rocks of comparable age in Massachusetts, Connecticut, and New Jersey.

Applications are being reviewed for the newly created position of Director of Research and Development at the Engineers Research and Development Laboratories, Corps of Engineers, U. S. Army, Fort Belvoir, Virginia. It is open to individuals with at least fifteen years' experience, exclusive of graduate work, ten of which should have been in research or as a research or development engineer. Five of the fifteen years' experience should have been as the chief of a branch or department of a research and development organization. The salary is $12,500 per year. Applications may be made either in person or by letter to the Commanding Officer at the Laboratories.

Scientific writers and medical statisticians are needed at the Communicable Disease Center of the Public Health Service in Atlanta, Georgia. It it highly desirable that applicants for both types of position have experience in the biological sciences. The positions are under federal civil service and salaries range from $4,479.60 to $10,305.00 per year (most of the jobs available are at the lower rate of pay). Further information may be obtained from S. R. Gervin, personnel officer at the Center.

The Public Health Research Institute of the City of New York has completed preliminary work toward setting up a laboratory for determining the Rh factor in human blood. Another laboratory recently developed performs virus diagnosis for physicians free of charge. Both laboratories are operated by the Bureau of Laboratories of the Department of Health.

Reserve commissions in the U. S. Army ranging from second lieutenant to a full colonel are available to qualified mathematicians and statisticians. Applicants must be citizens of the United States and between the ages of 21 and 55 inclusive. Full details of the commissioning program are provided in Department of the Army Circular No. 210, which may be obtained, together with application forms, from local Reserve Unit Headquarters or from Organized Reserve Unit Instructors, or by writing to Army Headquarters at New York, Baltimore, Atlanta, Chicago, Houston, or San Francisco.

The first license to manufacture oil from coal in the Union of South Africa was granted to the Anglo Transvaal Consolidated Investment Company. A designed capacity of 76,000,000 gallons of liquid fuel and oil a year is provided for and the coal will come from the deposits situated in the Vredefort district of the Orange Free State.

The Forest Service of the U. S. Department of Agriculture is studying means for avalanche control. Continuous skiing in some areas has been observed to keep the snow well enough packed so that it is not likely to slide. Recent experiments at Alta, Utah, showed that it is also possible to avert a slide by setting off explosives in danger spots when the area is clear of visitors.

Make Plans for—

American Mathematical Society, February 26, meetings in New York City and Chicago.

American Institute of Chemical Engineers, *regional meeting*, March 6–9, Los Angeles, California.

Institute of Radio Engineers, 1949 convention, March 7–10, Hotel Commodore and Grand Central Palace, New York City.

American Physical Society, Division of Solid State Physics, annual meeting, March 10–12, Hollenden Hotel, Cleveland, Ohio.

Optical Society of America, winter meeting, March 10–12, New York City.

Recently Received—

German gas turbine developments during the period 1939–1945. British Intelligence Objectives Sub-Committee Overall Report No. 12. British Information Services, 30 Rockefeller Plaza, New York 20, N. Y. $.35.

Fundamental education. (Bulletin 1948 No. 13, Office of Education.) Washington 25, D. C.: Supt. of Documents, U. S. Government Printing Office, 1948. $.10.

Bulletin of the American Physical Society, programme of the 1948 annual meeting at Columbia University, January 26–29, 1949. Lancaster, Pennsylvania: Prince and Lemon Streets. $1.00.

The memorial review. Published by the Women's Society of Memorial Hospital Center for Cancer and Allied Diseases, 444 East 68th Street, New York 21, N. Y.

Report of the Chief of the Bureau of Entomology and Plant Quarantine, 1948. Publication of the Agricultural Research Administration, U. S. Department of Agriculture. Washington 25, D. C.: Supt. of Documents, U. S. Government Printing Office, 1949. $.15.

Further new Cambrian Bellerophont Gastropods by J. Brooks Knight. (Publ. 3951.) Washington, D. C.: Smithsonian Institution, 1948.

Science and the Maintenance of Peace

Bart J. Bok

Harvard College Observatory

AT ITS MEETING IN PARIS (June 1948) the Committee on Science and Its Social Relations of the International Council of Scientific Unions voted to undertake an inquiry into some questions dealing with the subject of science and the maintenance of peace. It was decided to address the following two questions to a small but representative number of scientists who were known to have given considerable thought to the question of how scientists can contribute most effectively towards the maintenance of peace:

(1) In which measure do the methods of international scientific work contribute to the creation of an international spirit and to the maintenance of peace?

(2) In which ways could scientific organizations and scientists intensify their activities for the maintenance of peace?

At the request of the president of the CSSR, J. M. Burgers, of Delft, Holland, a number of these inquiries were distributed in the United States. The two questions were also discussed at the July meeting of the NRC Committee on UNESCO; several members of this committee have submitted answers. Since these questions are basic to the place of science in UNESCO, the NRC Committee requested the U. S. National Commission to devote time to discussion of these questions at the Panel Meeting on the Natural Sciences in Boston.

About 40 requests for replies and comments were distributed during the summer months. The present report represents an attempt to digest the opinions expressed in the 22 replies that have been received thus far. The names of those who contributed replies and their respective fields are as follows: I. Amdur (chemistry), I. S. Bowen (astrophysics), A. J. Carlson (physiology), R. Chambers (biology), R. E. Cleland (botany), K. T. Compton (physics), J. B. Conant (chemistry), R. W. Gerard (physiology), S. Goudsmit (physics), C. Kluckhohn (anthropology), S. Lefschetz (mathematics), W. T. Martin (mathematics), P. W. Merrill (astronomy), Melba Phillips (physics), W. O. Roberts (astronomy), H. N. Russell (astronomy), M. H. Stone (mathematics), O. Struve (astronomy), K. V. Thimann (biology), H. C. Urey (chemistry), M. B. Visscher (physiology), and D. Wolfle (psychology).

THE SCIENCES IN UNESCO

In the words of the preamble to the constitution of UNESCO, the organization was created "for the purpose of advancing, through the educational and scientific and cultural relations of the peoples of the world, the objectives of international peace and of the common welfare of mankind for which the United Nations Organization was established and which its charter proclaims."

The principal task of UNESCO is to create an international atmosphere of peace. The organization is charged with the responsibilities of getting the peoples of the world to know each other better and of assisting those who are now underprivileged to better their lot. The sciences have a place in UNESCO, not only because they have a big contribution to make toward the achievement of a better material life, but also because scientists are potentially among the most effective ambassadors of good will. *Pierre Auger,* who heads the Natural Sciences Department of UNESCO in Paris, writes in the UNESCO *Courier* for August 1948: "Scientists have always formed a world brotherhood. Their problems, and the solutions they sometimes find, are truly human and therefore international. What wonderful scope for the development of collaboration and brotherhood between the different countries of the world! The only spadework needed for mutual understanding between scientists is the mere understanding of the same language: if they have this, two botanists or two physicists from the most distant continents are immediately drawn together by strong common interests."

Harlow Shapley expresses himself on this same subject in the concluding paragraph of his recent address on "The One World of Stars": "Supranationalism and cooperation across national boundaries are so simple and effective in the sciences that we have a clear responsibility to lead the way into an era of peace and human progress without which our efforts for human knowledge and human comforts will have been in vain" (*Science,* September 24, 1948).

A DIGEST OF ANSWERS TO QUESTION 1

Almost all correspondents stressed the basically international character of science. *Cleland* expresses

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Interim report prepared by Dr. Bok as chairman of the National Research Council Committee on UNESCO, September 24, 1948.

this as follows: "Science deals with universal phenomena. There is no such thing as an English Law of Gravitation or an Austrian Law of Inheritance. Since the phenomena and laws with which scientists deal are universal, it is natural for scientists of all nations to work together in the solution of common problems, to disseminate their discoveries widely, to develop machinery by which constant international contact is maintained. No group in the world is more in the habit of maintaining cordial international relations than the scientists. No group is characterized by a greater measure of understanding between nationals of different nations. Freedom from racial and national prejudice is the norm among scientists."

The following direct quotations from several of our correspondents show that many scientists feel strongly that, because of the special nature of their work, they are in a favored position with regard to international collaboration:

Bowen: International scientific work brings about many direct contacts between scientists of different nations on the basis of their science. This cannot help but increase the mutual understanding of each other's problems and lead to the elimination of causes of friction.

Conant: It seems to me quite clear that the international character of science is highly important both for the progress of science and as part of the general cultural interchange so important for the maintenance of our civilization.

Gerard: Science is international in all respects. Its content is known to all who are interested. Workers in all countries work together for common ends and build on one another's efforts. Scientists have, in a real sense, a common and precise language. Individuals in far places know and respect each other and even form firm friendships at a distance. Travel to and work in foreign laboratories is common among scientists and forges lasting ties and sympathy.

Goudsmit: The desire and the need of the scientists for world-wide cooperation should be an encouraging example to a world that is sorely in need of the cooperative spirit. It is only by breaking down the barriers of dogma, mistrust, fear and secrecy, only by the free exchange of ideas and the widest possible dissemination of truth, that science can continue to raise its level, and with it, the level of our civilization.

Kluckhohn: Over the long run it seems to me clear that the methods of international scientific work do contribute to the creation of an international spirit and to the maintenance of peace. It is very difficult to live as a scientist and to remain a nationalist in the narrow sense. As one looks at the whole stream of human history it is evident that wider loyalties have developed as a result of individuals from hitherto separate groups discovering that they were pursuing the same goals and that their own interest could best be served by working together.

Merrill: Science seems to be one of the very few areas in which international cooperation is at present both practicable and useful. Here the troublesome questions of integrity and mutual confidence are at a minimum. Successful cooperation in this relatively easy field might serve the interests of peace by tending to preserve or enlarge contacts between various nations, and by suggesting and stimulating cooperative experiments in more difficult areas.

Thimann: It may often happen that a scientist's closest contact, from the point of view of work, is a man in a distant country; in scientific interests he may have more in common with that man than with any of his colleagues in his own institution.

Struve: No one can possibly doubt that the methods of international scientific work contribute immensely to the creation of international solidarity among the peoples of the world and to the maintenance of peace. As an astronomer I am daily concerned with problems which not only transcend national boundaries but reach far out into space beyond the limits of the solar system and even our galaxy. I fervently believe that the ultimate aims of all mankind are the same and that the astronomers perhaps even more than other scientists must carry the message of world peace to those who have not the advantage of scientific thought.

Visscher: A real and natural basis for friendly association may be easier for scientists than for persons in most other occupations because science is naturally an international enterprise, its methods are universal, verbal factors are of minimal importance to it, and because factors of race, religion and nationality have nothing fundamental to do with progress in science.

Wolfle: The scientists themselves in their scientific work are probably as free from restrictions imposed by national boundaries as any group in the world. We read each other's reports (within the knowledge of our linguistic abilities), draw upon each other's results, combine findings, meet in international congresses and include representatives of other countries among our friends pretty much without regard to racial or national boundaries or differences. We might in a sense, therefore, serve as a model of international-mindedness as long as we are unfettered by nonscientific controls.

While most of our correspondents express the opinion that science and scientists have an important mission to fulfill in fostering international collaboration, some warn us not to expect too much, and one says that the net result is zero. The following quotations are especially pertinent in this respect:

Carlson: Science is one and is consequently international. It could be rendered more international if scientists and science were identical. But, unfortunately, scientists are just human beings and do at times depart from the strict path of science, that is, do not always follow the proven facts with all the cards on the table face up. They do sometimes indulge in the common world practice of artistic lying.

Compton: It is quite a common experience for a scientist in one country to feel almost intimately acquainted with a scientist in his field in some other country, even though the two may never have met. So far as it goes, this is all to the good, and the more that it can be encouraged the better. *However,* I think it is clear that scientists form too small a proportion of the entire population to make this factor anything more than a relatively small influence, but it will generally be in a good direction.

Phillips: The internationalism intrinsic in scientific work does result in a community of feeling between scientists everywhere and is part of an "international spirit." But the extension of the methods of international scientific work to other aspects of international relations, while devoutly to be hoped for and worked toward, is not to be caught in a phrase or even in a solemn treatise. The ICSU is not going to be able to do very much about it, by itself.

Urey: I believe that merely scientific contact of scientists has comparatively little to do with securing peace. Peace is the by-product of responsible government, and not a by-product of a discussion of the origin of the carbon and nitrogen atoms in uric acid or the discussion of cosmic rays. UNESCO is important, as are all other international organizations, both scientific and otherwise, for without the community of interest which they establish responsible government cannot be established over the present divergent national groups of the world; but scientists will make a mistake if they think that their scientific activities are the direct way to accomplish this end.

In the listing of achievements, our correspondents stress those of the past quarter-century or so made by the present international scientific organizations, notably the unions, and they emphasize the importance of meetings. Almost without exception they point to the effectiveness of international exchanges of personnel at all levels. They comment favorably on international exchanges of scientific literature and on the advances made in scientific abstracting. The importance is stressed of several projects undertaken by the Natural Sciences Department of UNESCO, notably the establishment of the Field Science Cooperation Offices, the creation of the Hylean-Amazon Institute, the work on scientific reconstruction and that on the popularization and social implications of science.

Roberts expresses the opinion that the methods of science lead to world-wide cooperation and mutual understanding. He writes: "A basic factor in the method of science, for example, is the elimination of personal bias from the interpretation of events of the surrounding world. It is nearly impossible for scientists to avoid carrying over this impersonal approach when they assess politics or other social endeavor. Thus the method of science provides a way for men to put aside the conventional signal reactions, prejudices, and many of the other blocks to understanding things that are unfamiliar.

"Another factor in the method of science is the appreciation that must come to all scientists—that the development of theories is always an evolutionary thing and never static for long. This helps men to understand that their social theories, like all theories, are in the process of gradual change—that no sole theory or complex of theories is sufficient for all times or all places and that all systems will evolve in one direction or another at one rate or another—thus the method helps provide the flexibility of mind that is necessary if we are to maintain peace in a world inhabited by proponents of diverse and sometimes conflicting social schemes.

"Just to mention briefly one other essential feature of the method of science, I believe that the principle of freedom of inquiry which all good scientists must possess is a great asset in the maintenance of world peace. It is engrained in the spirit of scientists that in their progress there are no man-made absolutes, and that the ultimate principle by which all theories stand or fall is not authority, or force of will, but solely experiment—solely how well, how simply, and how usefully a given theory explains and predicts the various phenomena of the universe. This fundamental freedom is hard to reconcile with doctrinaire politics and impossible to reconcile with dogmatic adherence to particular theories of social or physical organization imposed by the dictation of a leader."

A Digest of Replies Received to Question 2

Natural Resources and Overpopulation. Several correspondents express extreme concern over the problems of overpopulation and lack of natural resources as they bear upon the maintenance of world peace. *Stone* writes: "It is only through the applications of science on an international basis in agriculture, industry, public health and population control that a balance between our limited world resources and our consumption can be achieved at a relatively high standard of living and one of the most dangerous causes of aggression and war eliminated." *Lefschetz* expresses the opinion that the explosive growth of population everywhere is the principal long range cause for war. A clash between the United States and the Soviet Union (mainly due to lack of understanding between the two sides) is, according to *Lefschetz,* the most important cause for war in the immediate future.

Carlson writes: "The known factors that lead to war are overpopulation, undernutrition, uncontrolled greed, and antediluvian religions and philosophies. We know now on the basis of science that the present human race is one species and that there are saner and better ways of meeting human food needs and controlling excess human reproduction than the methods of war."

Two sample quotations may suffice to show the importance which scientists attach to the world's natural resources.

Amdur: To focus the attention on the use of science for conserving and developing the world's resources is one of the most effective ways for scientists and scientific organizations to contribute to the maintenance of peace. No single cause for wars can definitely be said to be the most important one, but I am sure that if the world's resources could be developed to take care of economic needs of peoples to a greater extent than in the past, those causes of war which are tied up with economic rivalries would be much less important.

Cleland: Most modern wars have been brought about as the result of economic pressures, based on the Malthusian principle. Only science can remove the basis of these pressures. Scientific control of population, the production of more efficient crop plants and domestic animals, the proper exploitation of vast areas of potentially usable land, control of soil erosion, development of irrigation and other projects designed to increase arable land, the discovery of new sources of energy—these are activities which will remove the chief cause of war. Without such activities, no amount of talk or education will achieve lasting peace.

UNESCO's activities in connection with the forthcoming United Nations Scientific Conference on the Conservation and Utilization of Resources are wholly in line with the above suggestions, as are the attempts to assist in the formation of an international union for the protection of nature.

International Unions and Congresses. The majority of our correspondents, notably Bowen, Cleland, Conant, Compton, Martin, Phillips, Roberts, Russell, Struve, Thimann, Visscher, and Wolfle, attach a great importance for the future to continued support of the work of the international scientific unions, and they urge holding frequent international scientific congresses.

Cooperative Research. A number of correspondents point to the importance of cooperative research projects with scientists as individuals, or institutions, from two or more nations collaborating. The following sample quotation shows that scientists would welcome the establishment of international laboratories and observatories under United Nations auspices:

Merrill: International laboratories might be established for intensive research on the great health problems of mankind, for example, cancer, arthritic diseases, the common cold. A large cooperative astronomical observatory in the Southern Hemisphere might be considered. Possibly an improved world calendar could be advocated.

Exchanges, Fellowships and Scientific Missions. *Martin* lists as one of the most important activities the "wide exchange of scientists and scientific students on a visiting basis with travel and passport regulations as simple and flexible as possible." This same thought is expressed clearly by *Cleland* who writes: "We must enlarge as much as possible existing programs for the exchange of students. Nothing can be more effective in bringing about mutual understanding than giving large numbers of students the opportunity to study in other lands and to become acquainted with other peoples at the time in life when they are still plastic and impressionable. The more students can experience a satisfying experience abroad, the more nearly will we approach the goal of mutual sympathy and understanding."

An interesting suggestion is made by *Thimann*: "Without doubt one important way in which the international spirit of science could be increased and given more impetus is by increasing the *personal* contacts among scientists of the world. The exchange of personnel that now goes on, while very useful, influences only a very small fraction of the men involved. We need a very much greater exchange of personnel in the form of visiting lectureships and travelling fellowships. These should not be mere tours of inspection but should involve actual residence for not less than a term or perhaps a year. They should involve not only university staff and students but men working for Government and industry. Travelling fellowships for industrial scientists would be particularly useful.

"Towards the close of the 19th century it became very common for biologists and chemists of England and America to go to Germany for graduate work and to take their doctorates there. Arrangements of this kind involving a *really* large fraction of the total scientific men are needed. Practically every scientist should, by age 30, have spent at least a year studying abroad."

Gerard and *Visscher,* who have both participated in the medical mission organized by the Unitarian Service Committee, stress the importance of international scientific missions organized with the specific aim of aiding and assisting the scientists and the population of the region. *Roberts* points to the need of simplifying the movement of scientists across national boundaries. He writes: "Every effort should be made to simplify the passport and visa requirements to give scientists freer access to all countries. If the many-times-proposed plan for the issuance of 'UNESCO passports' could be worked out so that people carrying these passports could have free access to all UNESCO countries, it would be a great step in the right direction."

On the same subject *Stone* writes: "Scientists and their organizations can contribute to the maintenance of peace by working to break down artificial barriers to communications, travel, and cooperative endeavor which seriously obstruct the development of world science in all its aspects, including its application to some of mankind's most pressing problems."

Popularization and Social Implications of Science. The principal recommendation made by *Carlson* is the following: "More factual scientific education and understanding of the populations in all lands would greatly diminish the drives or needs for war. In my judgment and experience, this phase of education on an international scale is primarily a social responsibility of the scientists."

Amdur expresses the opinion that continued popular education in the field of atomic energy is needed. *Gerard* feels that a big opportunity is being lost since we are not stressing to a greater extent the popularization of the use of the scientific method and since we are not attempting to introduce this attitude early in the formal education of our children.

Gerard and Visscher urge the fullest support of the social sciences. We quote them as follows:

Visscher: The scientific method can and must be applied to the greatest problems of human life, the problems raised by peoples having to live with one another on a single planet made small by the advances in the physical sciences. All prior attempts to create conditions conducive to peace have failed. Man must be allowed to use the constructive power of the scientific method in this sphere. This method is not a tool of infinite utility, but, until its usefulness in this area has been exhaustively tested, no one has grounds for rejecting it. The survival of the human race as a whole is in jeopardy today.

Gerard: The social sciences are still feeble and groping, and mental ones hardly less so, and many maintain that human problems must remain extrascientific. Most scientists are convinced otherwise; and this position at least has the merit of inviting rather than dissuading effort. Other modes of thought and feeling have been tried and have failed to achieve harmony among men. The mode of science—rational extrapolation from reliable knowledge, subjected to operational test—may also fail, but it surely deserves its trial. This is, indeed, also the avowed mode of democratic government and is being approached, however slowly, in actuality.

Publications and Abstracting Services. General approval is expressed of UNESCO's activities in the field of abstracting and international scientific publications. *Chambers* expresses the belief that "an international spirit in scientific work would be greatly aided by the establishment of more active international polyglot (English-French-German-Italian) scientific journals." *Struve* makes the following suggestion: "It would be important to stimulate a more active exchange of scientific publications and develop a system whereby scientific articles by American workers may be published abroad while papers by foreign authors may appear in American journals. Difficulties of exchange now make it impossible for European institutions to pay the cost of publication in America, but an exchange of publications might well remove this difficulty."

The Twilight Areas of Culture. *Cleland* writes: "Scientists in the more advanced countries should do everything possible to encourage science in the less favored areas, by training increasing numbers of foreign students, by consenting to serve as visiting professors or as members of commissions sent to other countries to encourage and assist in developing their scientific programs, by acting as consultants in the solution of nutritional, medical or other problems confronting the scientists of other countries, by taking an active interest in the international scientific unions, by lending support to all international scientific agencies, by contribution toward the rehabilitation of devastated laboratories and libraries, and any other way possible."

Stone: Scientists and their organizations can continually and vigorously urge the need for so organizing education in all countries that a sufficient number of adequately trained scientists will be available to each national group in its attempt to share in the benefits conferred by science.

Phillips urges that special attention should be given to the encouragement of scientific growth in backward countries. She points further to the continued need for activities in the field of rehabilitation of science in war-devastated countries. It appears that the majority of our correspondents is agreed that UNESCO's Field Science Cooperation Offices fill a distinct need and that UNESCO has done very useful work through its program of scientific rehabilitation.

CONCLUDING OBSERVATIONS

Scientists and Citizens. *Compton* writes: "I happen to be one who feels that the responsibilities of scientists are just like the responsibilities of any other group of citizens when it comes to the matter of responsibility for peace. I do not believe that it is feasible or, in the long run, safe for scientists to attempt to exert their own controls on the products of their work. They are but one of the contributors to our intellectual and economic strength and it is the impact of the population as a whole that has the predominating control, in my judgment."

Russell agrees with this view and writes as follows: "The problem of maintaining peace is so deeply entangled with many sincere differences of social and political belief that, in my judgment, it would be unwise for scientific organizations, as such, to endorse any particular programs. It is better for individual scientists to act as citizens, in cooperation with others who hold similar convictions."

In a letter bearing on the subject *Bowen* writes: "Projects should be planned primarily from the standpoint of the advancement of science involved in the most effective manner. If the scientific standpoint is made secondary to deliberate peace propaganda, the whole program will become political in nature and very little will be accomplished either in the advancement of science or of peace."

A remark by *Roberts* deserves to be quoted at this point: "I feel that it is actually far more important for them to join their efforts in a genuinely important scientific problem than it is for them to try to bridge the political chasms that exist by any direct action."

The Iron Curtain. Most correspondents refer in one way or another to the urgent need of lifting the "iron curtain," which separates the East from the West. The astronomers quote several instances in which the iron curtain has been pierced in recent years through sincere efforts from scientists on both sides. But the curtain admittedly becomes more real every day. Some are quite pessimistic. *Conant,* for example, writes: "It is hardly possible for the scientists as such to affect the practices of certain countries in which freedom of travel is highly restricted and which more and more appear to be using academic men as propagandists of special views of essentially a political nature. Perhaps patience and continued endeavors to promote international exchange along old-fashioned lines is all that we can hope for in these troubled times. I am a firm believer that better days will sometime dawn and as times improve, the chances of having international scientific meetings with their old spirit may also improve."

Others feel that the time for action is by no means over. The following two quotations take this point of view:

Struve: Unrelenting efforts should be made to remove from the field of science the present division of countries on two sides of the "iron curtain." In particular, efforts should be continued to bring about a more active participation in scientific organizations of the scientists of Russia and of countries in the Russian orbit. That such efforts can be successful has been strikingly demonstrated by the invitation recently confirmed to hold the 1951 International Astronomical Union in Leningrad.

Thimann: The second most important step forward will be taken when free exchange not only of men but even of publications and research results takes place with the Soviet Union. The present tendency of Soviet journals to omit presentation of summaries in English, French or German represents a serious loss of the international spirit. Free correspondence with Soviet scientists is also necessary. If it were possible to extend the exchange of personnel mentioned above to the Soviet Union, even in small part, this would be perhaps the most important activity which scientists could undertake for the maintenance of peace.

Kluckhohn fears that scientists will be able to influence only to a very slight degree the various governmental interferences with the freedom of movement across national boundaries and the freedom of expression. He writes, however: "It is all too true at the moment that certain individuals in certain countries label even the most detached of natural science enquiries in accord with competing ideologies. However, I cannot but feel that this is only a temporary phase which cannot endure. The deepest loyalty of the scientist is inevitably to the facts of nature which know no ideological boundaries."

Science Fosters Peace Rather Than War. Nonscientists frequently charge that modern science is basically destructive. Vigorous objections against this point of view are voiced by our correspondents.

Cleland: The impression that science fosters war rather than peace is based upon a misconception of the activity of scientists and of the breadth of the field of science. Many nonscientists have a myopic view of science, being impressed with the effectiveness of physics and chemistry in the late war and forgetting the many sciences whose fields contribute only to the arts of peace; forgetting also the fact that the major activities of physicists and chemists have always been devoted to the building of a richer civilization. Their efforts have only incidentally been directed toward wartime objectives, and only unwillingly and under stress of emergency. No group is more conscious of the disastrous possibilities of war in the atomic age than the scientists themselves. No group has been as vocal as the nuclear physicists in condemning war and in supporting efforts to achieve world-wide cooperation.

In discussing the biological sciences *Gerard* writes: "The biological sciences, however, have also reached the stage of expanding application, and life expectancy is rising precipitously. The X-ray alone saved more lives than were lost in World War I, and who can doubt that antibiotics will far more generously cover the losses of World War II. Such facts are not dramatized and are little known. Indeed, science has, with the exception of a few devoted scientists, preferred an esoteric status and has insulated itself from its society. This must be radically altered."

Funds to Fight for Peace. ***Roberts*** adds new emphasis to a suggestion that has been made several times in the past. We reproduce his comments here without further remarks: "Another thing which has been discussed many times, and which to me appears to possess great merit, is the proposal that some specific percentage of all funds expended for purposes of national military defense be expended in specifically peacetime and humanitarian activities. The details of the administration of such a program have been discussed by a number of people, and I feel that several satisfactory and workable plans have been offered. One of the best of these, to my way of thinking, is the establishment of an actual cabinet post and entire government department for these functions and activities. The benefits and findings of this department should, I believe, be made freely available throughout the world, without regard to nationalism, without regard to politics or prejudices. Perhaps this is a bit visionary and utopian, but to me it seems immensely sound."

Ultimate Aims. Several correspondents allude to the ultimate aims toward which the work for world peace must lead. *Urey* sees this in the establishment of world government. He writes as follows: "In attacking a large scientific problem, we all go back to fundamental principles, and we face our problems fairly and squarely. If they involve very difficult things, we nevertheless recognize that our problems are difficult and do not try to solve major problems by following up side issues or the minor fringes. The problem of securing peace is the greatest that humanity has ever faced, and scientists will do their best in furthering this problem if they frankly recognize the fundamental problem, namely, world government, and speak those words firmly and fearlessly whenever the question is introduced. Without this there is no hope anyway."

Several correspondents point to the value of world-wide cooperation in science as an example for similar cooperation in other fields:

Goudsmit: Not until the world realizes that world-wide cooperation is necessary, not only for the progress of science but for the progress of all phases of civilization, can we hope for lasting peace. As science is only a small fraction of human endeavor, its influence is not large enough to promote this cooperation beyond its own boundaries. Scientific organizations can, however, make known to the world the benefits they derive from such cooperation.

Stone: International cooperation in science gives valuable experience and training in the conduct of activities directed to a high purpose above purely nationalistic considerations, and can point the way for similar enterprises undertaken to solve the common problems of nations.

Perhaps the attitude of science is summarized best in the following cautious words of *Wolfle*: "It is a matter of hope rather than one of history that the increasing knowledge of the world, improved communications and transportation of goods, and raised standards of living can minimize the causes of war by reducing needs of aggression. The hope is, however, one that is worth mentioning and worth establishing as a goal for our political thinking."

Sir D'Arcy Wentworth Thompson, C.B., F.R.S. (1860–1948)

Robert Chambers, *New York University*

SIR D'ARCY WENTWORTH THOMPSON, one of the greatest academic figures in biological science, was a true naturalist with a wide range of intellectual interests and attainments. A Greek scholar, he possessed a unique sense of the classics, which he brought into his interpretations of contemporary scientific thought.

Biologists of past generations mastered much of the knowledge of their times in all known fields of the natural sciences. With the passage of time each of these fields has been so greatly developed that specialization has been the inevitable result, and biologists, along with other scientists, have become largely specialists. Sir D'Arcy belonged to neither category, encyclopedist or specialist. His strength lay in his attention to broad, simple principles developed through extensive knowledge of ancient and modern philosophical thought. His was an integrated outlook, based on broad understanding of these principles and appreciation of mathematics with its precision, and nature with its greatly varied phenomena.

Thompson, born in Edinburgh, Scotland, May 2, 1860, was the grandson of a shipmaster of Maryport, Cumberland, England. His father, also D'Arcy Wentworth, was born at sea off the coast of Van Dieman's Land, attended Pembroke College, Cambridge, and became classical master at the Edinburgh Academy and afterwards professor of Greek at Queen's College, Dundee. The father was alive to social and educational problems of the day. His liberal ideas are expressed in his books, written in a whimsical and fascinating style: *Daydreams of a schoolmaster* (1864), and *Wayside thoughts*: *being a series of desultory essays on education* (1868). The latter covers the subject matter of his twelve Lowell Institute Lectures, delivered in Boston during the season of 1867–68. In these lectures he also paid tribute to the New World for having done so much for women's rights.

His mother, Fanny Gamgee, belonged to a family distinguished in science and in medicine. Privileged in having such a background, the son in addition showed an intense love of nature from his early boyhood throughout his life. His preliminary studies were at Edinburgh Academy, a school long famous for the brilliant scholars it turned out. At the age of 17 he matriculated as a medical student at the University of Edinburgh. There he came under the influence of Sir Wyville Thompson, who had lately returned from the Challenger Expedition. At the age of 19 D'Arcy Thompson published a couple of papers on hydroid taxonomy and on a Pleistocene fossil seal. After two years in Edinburgh he obtained a classical scholarship which took him to Trinity College, Cambridge. There his inclinations towards zoology were furthered by his contacts with F. M. Balfour and Michael Foster, who were then laying the foundations of the modern Cambridge School of Biology. For a year he served as demonstrator in Michael Foster's laboratory of physiology. While at Cambridge he translated H. Muller's work on the fertilization of flowers, which was published with an introduction by Darwin. Concerning this D'Arcy Thompson wrote: "Charles Darwin's preface, full of suggestion, full of kindly appreciative feeling, is of peculiar interest as one of the very last of his writings." In 1884, at the early age of 24, he was appointed professor of biology in the recently founded University College in Dundee. In 1897 the College was united with the University of St. Andrews and he became a member of the Senate. Later, he was appointed to the senior chair of natural history in the United College of St. Salvator and St. Leonard, St. Andrews, Scotland. His tenure of the chairs at Dundee and at St. Andrews had extended for 64 years when he died at the age of 88.

In 1896 and 1897 Sir D'Arcy went to the Bering Sea as a member of the British-American inquiry into the fur seal fishery, and represented Britain in the international conference on the subject at Washington. For these services he received the title of Companion of the Bath in 1898. He was one of the British representatives on the International Council for the Study of the Sea from its beginning in 1902, and he edited and contributed largely to the Scottish section of its reports. He also wrote many papers on fishery statistics and oceanography in the Scientific Investigations of the Scottish Fishery Board from 1913 to 1931.

In 1908 he published a short paper in *Nature* on "The Shapes of Eggs and the Causes which Determine Them." This was the first published intimation of a line of inquiry that had long engaged his thought and on which he had accumulated masses of notes.

His book *On growth and form* appeared in 1917. This immediately attracted attention both because of its novel approach and because of its mass of illustrative material gathered from ancient and modern writers. In his own words: "The road of physicomathematical or dynamical investigation in morphology has found few to follow it; but the pathway is old. The way of the old Ionian physicians, of Anaxagoras, of Empedocles and his disciples in the days before Aristotle, lay just by that highway side. It was Galileo's and Borelli's way; and Harvey's way, when he discovered the circulation of the blood. It was little trodden for long afterwards, but once in a while Swammerdam and Reaumur passed thereby. And of later years Moseley and Meyer, Berthold, Errera and Roux have been among the little band of travelers. We need not wonder if the way be hard to follow, and if these wayfarers have yet gathered little. A harvest has been reaped by others, and the gleaning of the grapes is slow. . . . Morphology is not only a study of material things, but has its dynamical aspect, under which we deal with the interpretation, in terms of force, of the operations of Energy. And here it is well worth while to remark that, in dealing with the facts of embryology or the phenomena of inheritance, the common language of the books seems to deal too much with the *material* elements concerned, as the causes of development, of variation or of hereditary transmission. Matter as such produces nothing, changes nothing, does nothing; and however convenient it may afterwards be to abbreviate our nomenclature and our descriptions, we must most carefully realise in the outset that the spermatozoon, the nucleus, the chromosomes or the germ-plasma can never *act* as matter alone, but only as seats of energy and as centres of force."

The central theme of the book is an enquiry into how far the form and structure of living things can be interpreted in terms of physical forces acting within the lifetime of an organism. This method of approach of causal morphology is to be distinguished from the historical morphology which was the almost exclusive study of the preceding period.

At the insistence of many friends he published in 1942 his second much enlarged edition (1116 pp. Cambridge University Press and the Macmillan Company) in which he emphasizes "the twofold problem of accumulated inheritance and of perfect structural adaptation [which] confronts us and passes all understanding." Dorothy Wrinch, who knew D'Arcy Thompson well, says, in her review of the book in *Isis*:[1] "One experiences, page by page, the feelings of a guest at a banquet of learning and insight, of knowledge and feeling. Those who wish to add to our fundamental understanding of biological structures must arm themselves with weapons from other sciences, yet at the same time develop to its highest pitch a proper feeling for biological materials. As we feed ourselves at this table groaning with good things, we see that one biologist at least accomplishes this."

A striking testimony to the influence of this book is given in a volume of "Essays on Growth and Form presented to D'Arcy Wentworth Thompson" edited by W. E. LeGros Clark and P. B. Medawar, published by the Clarendon Press in 1945. In this volume is included his bibliography.

Sir D'Arcy's classic leanings are expressed in his studies on the natural history of the ancient world. His *Glossary of Greek birds* appeared in 1895 and a second edition in 1936; his translation of Aristotle's *Historia animalium* was published in 1910 and his *Glossary of Greek fishes* in 1945. One of his invaluable services was as a member of a staff for the revision of Liddell and Scott's Greek-English Lexicon (Clarendon Press).

Concerning his glossaries Sir D'Arcy states: "Many old bird names and fish names are recorded by Italian scholars from the rich dialects of Italy, and new light is thrown thereby on obscure Greek and Latin; but the dialects of Modern Greece are still all but unknown. Some day, scholars will explore, to our great advantage, the common speech and folk-lore of the bird-market of Athens and the fish-market of the Piraeus, and of all the islands and all the provinces of Greece.

"Many a Greek word or hero name was foreign to Aryan speech. The merchant and mariner had brought strange words home from overseas; and many a beast and bird and hill and river had kept its pre-Hellenic name, harking back it might be to the nameless and forgotten language which was spoken by the Gods."

A brilliant essay is his "Science and the Classics," delivered as his presidential address to the Classical Association, Cardiff, and published in *Nature*, May 25, 1929. Its allusions open up a wealth of beauty and appreciation by showing the significance of the terms used for objects of nature in their relations to stories in prose and poetry of the ancient writers.

His quest was not so much a thirst for knowledge as for the thrill of revealing beauty. The following is quoted from the last paragraph of his address: "Whether we be taught science or the classics in our boyhood is not the last word of all. But whichever of the twain it be, let us so learn it as to live it, and so love it that we may love it to the end. Science and the classics—both alike continually enlarge our curiosity, and multiply our inlets to happiness."

His writings and speeches are rich with literary allusions and their volume attests to his fertile mind and breadth of knowledge. John L. Myers once asked him concerning the Homeric description of the death struggle of Nestor's chariot horse which Jupiter caused to be struck through the forehead by the arrow of a thunderbolt. The reply was immediate: "The arrow had grazed the cerebellum and the convulsive

(*Continued on page 151.*)

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[1] Dorothy Wrinch, *Isis*, 1942–43, **34**, 232. See also G. Evelyn Hutchinson, *American Scientist*, 1948, **36**, 577; Frederick S. Hammett, *J. Hered.*, 1943, **34**, 85.

The Path of Carbon in Photosynthesis IV: The Identity and Sequence of the Intermediates in Sucrose Synthesis[1]

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THE IDEAL DESIGN OF AN EXPERIMENT to determine the chemical path of carbon from carbon dioxide to the variety of plant constituents is relatively simple and straightforward. It would consist of feeding a photosynthesizing organism radioactive carbon dioxide for various lengths of time and stopping the reaction by killing the plant. By determining those compounds into which the radioactive carbon has been incorporated for each period of illumination and, further, by determining the distribution of radioactivity within each compound, these data could then be used to construct a family of curves depicting the increase in radioactivity in each compound (and in each carbon atom of each compound) as a function of time. From a complete set of such curves it should be possible to draw a map of the path of carbon as it flows into the plant in the form of carbon dioxide and distributes itself among all the plant constituents.

A few such experiments have already been reported (*1–4, 6*). The present paper reports some further experiments toward this end with specific reference to the synthesis of sucrose.

The data are in the form of radioautographs of paper chromatograms made from the extracts of algae which have been photosynthesizing for several different periods of time, as well as one showing the dark fixation after a preliminary period of illumination in the absence of carbon dioxide.

Exposure of algae to $C^{14}O_2$: One-day-old *Chlorella pyrenoidosa* cells were grown under continuous culture conditions (*3*) and harvested immediately before use. A suspension of 1 cc of packed cells in 70 ml of water containing fumarate buffer (3.5 mg fumaric acid plus .032 meq sodium hydroxide) was allowed to photosynthesize for 30 minutes with 4% carbon dioxide in air. This gas mixture was then displaced by rapid flushing with air during 5 minutes. A solution of 40 μc of $NaHC^{14}O_3$ (.0143 mmol) in 0.20 ml was rapidly injected into the suspension. The vessel was shaken vigorously in the light beams (2 × 17,000 lux) until the algae were killed by opening an 8-mm stopcock and allowing the solution to flow into a beaker containing 500 ml of boiling absolute ethanol. The alcohol suspension was filtered with celite and evaporated at room temperature to a volume of 2 cc for convenient application on the filter paper sheet.

Preparation of chromatograms: Fumarate buffer in distilled water was chosen for this work, since inorganic salts, especially phosphates, interfere with movement of compounds on the paper. Alcohol extract of as much as 100 mm³ of algae may be applied to the filter paper (Whatman No. 1). Development in water-saturated phenol was followed by thorough drying at room temperature. The second solvent was freshly prepared before use from equal volumes of the following solutions:

(A) 1,246 cc *n*-butanol—84 cc water

(B) 620 cc propionic acid—790 cc water[2]

In order to choose a suitable exposure time for the X-ray film (Eastman No-Screen, 14″ × 17″) the activity of the original spot is determined on the paper. With the number of compounds appearing in a 90-second photosynthesis, an activity of 30,000 cpm is sufficient to expose the film in 48 hours.

Although the radioactive fixation products which have been separated in the chromatogram may be eluted and their activity determined accurately, the radiogram serves as a semiquantitative record of the activity fixed in each compound. The relative amounts of each active product may be compared visually in the radioautograph.[3]

An examination of the radiograms reveals that in the very short photosynthetic experiments (30 seconds and 90 seconds) by far the major portion of the newly reduced carbon dioxide is found in the phospho-

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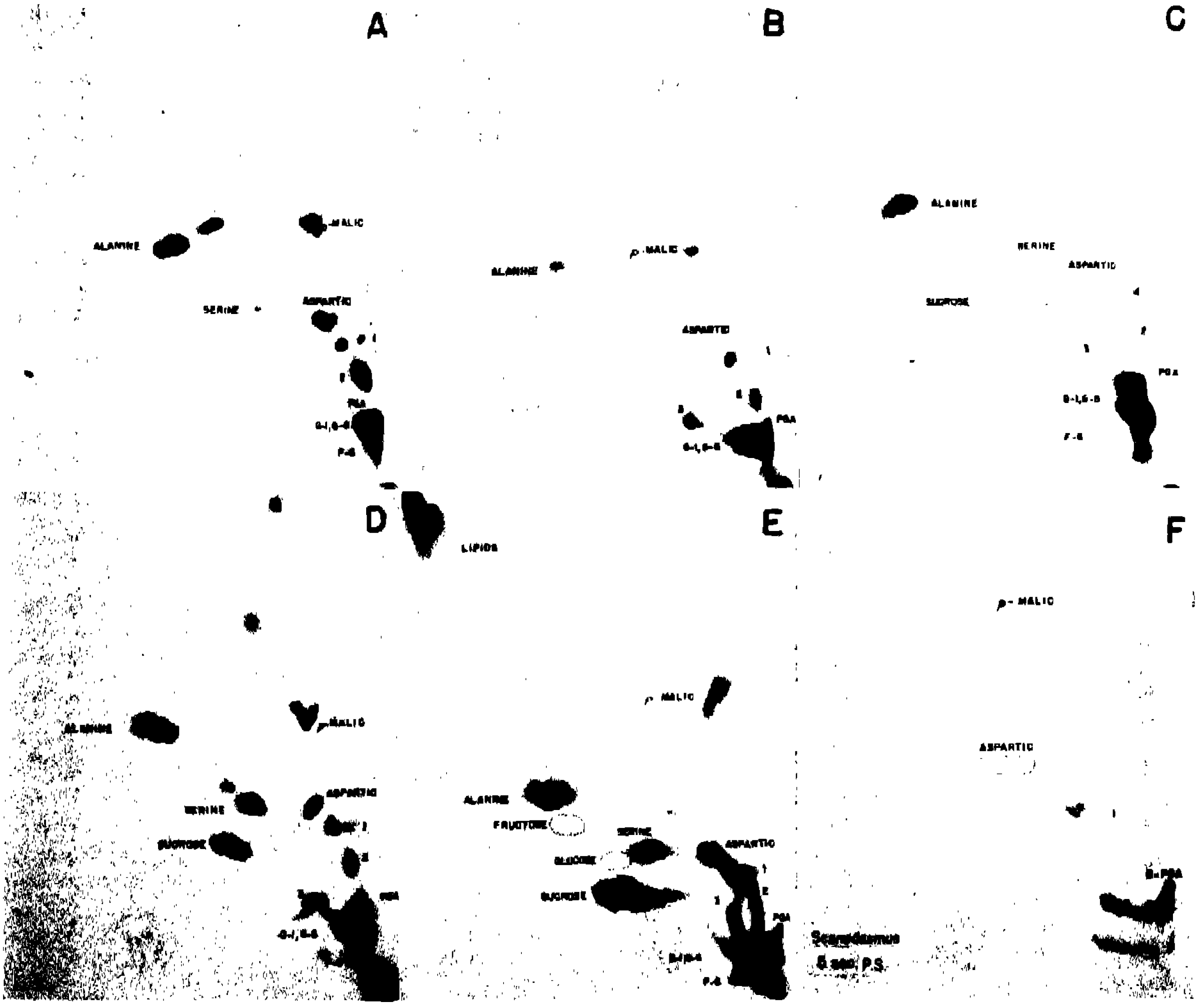
[1] This paper is based on work performed under Contract No. W-7405-Eng-48 with the Atomic Energy Commission in connection with the Radiation Laboratory, University of California, Berkeley.

[2] The solvent is adjusted to separate into two phases if cooled two degrees below the temperature at which it is used.

[3] The details of the methods of identification of the spots will be published elsewhere. ("The Path of Carbon in Photosynthesis. V. Paper Chromatography and Radioautography of the Products" by A. A. Benson, J. A. Bassham, M. Calvin, V. A. Haas, and W. Stepka.)

glyceric acids, triose phosphates and the hexose phosphates. This may be taken as additional confirmatory evidence of our previously proposed (*4*) scheme by which the six-carbon hexose skeleton is synthesized through the usual glycolytic intermediates. The details of the path by which the phosphoglyceric acid is formed and the relative rates of the several reactions involved in its conversion to hexose phosphate will be treated in subsequent publications.

What we would like to point out here is the fact that the first free carbohydrate which appears in these plants is sucrose. The positions taken on the chromatogram by free glucose and free fructose are known and they do not contain radioactivity. The nonappearance of radioactivity in a given compound does not necessarily preclude the possibility of its playing a part as an intermediate in a given sequence. For example, the reservoir of this compound in the sequence



C^{14} RADIOGRAMS OF 80% ETHANOL EXTRACTS OF ALGAE[1, 2]

A: 15-sec dark fixation by *Chlorella* which had been preilluminated for 15 min in helium. B: 5-sec photosynthetic fixation by *Chlorella*. C: 30-sec photosynthetic fixation by *Chlorella*. D: 90-sec photosynthetic fixation by *Chlorella* (10% of the activity fixed is insoluble in 80% ethanol). E: 5-min photosynthetic fixation by *Chlorella*[3] (60% of the activity fixed is insoluble in 80% ethanol). F: 5-sec photosynthetic fixation by *Scenedesmus*.[4]

[1] The term "radiogram" is used here to denote the radioautograph of a two-dimensional paper chromatogram.

[2] The abbreviations used in labeling the radiograms indicate the following compounds: PGA, phosphoglyceric acid; G-1, glucose-1-phosphate; G-6, glucose-6-phosphate; F-6, fructose-6-phosphate; p-MALIC, malic acid (position dependent on pH).

[3] Dotted circles indicate the positions of fructose and glucose which are not radioactive.

[4] Aspartic acid, encircled in the radiogram, was identified by ninhydrin spraying and has a small amount of radioactivity.

may be extremely small, or the compound may never exist as a free compound in solution but rather only as an enzyme-substrate complex, so that the amount of radioactivity present in that particular compound may be so small as to be missed. Conversely, the appearance of radioactivity in a particular compound does not necessarily prove its part as an intermediate in a direct sequence. It can be, and often is, the result of a side reaction.

It does not seem likely that, if free glucose or free fructose were intermediates in the synthesis of sucrose, they would fail to appear radioactive either prior to the appearance of radioactive sucrose or simultaneously with it, as is the case in the present experiments. We are, therefore, led to suggest that the immediate precursors to sucrose are two hexose phosphates. That one of them is glucose-1-phosphate can be taken as relatively certain in view of the large amount of radioactivity found in this compound, as well as its demonstrated participation in sucrose synthesis by an isolated enzymatic system (*5*). If the other is fructose-6-phosphate, which has also been identified among the radioactive compounds in the early chromatograms, one might expect a sucrose phosphate in which the phosphorus is attached to the fructose fragment as the intermediate just prior to the formation of free sucrose. Although it is not required that this intermediate be found, since dephosphorylation may take place simultaneously with the condensation to sucrose, there are still a number of unidentified spots in the chromatograms, one of which might well be a sucrose phosphate.

That the fructose phosphates are formed prior to the glucose derivatives is suggested by the fact that the fructose half of the sucrose formed in 30-second photosynthesis by *Chlorella* has approximately twice the specific radioactivity of the glucose half. This was determined by cutting out the sucrose spot from a chromatogram of the total extract, eluting it from the paper, hydrolyzing for 10 minutes in 0.1 N HCl at 80° C and rechromatographing the hydrolyzate after cold evaporation to dryness to remove the HCl. The sucrose formed in 90-second photosynthesis by the same organism is made up of glucose and fructose of equal specific activities (within 5%). This result requires that the functioning reservoirs of precursor hexose phosphates be so small as to achieve equal specific activities in 90 seconds.

Additional evidence for the size of the functioning reservoirs and the speed of turnover may be obtained from a knowledge of the molar specific activity of a compound relative to that of the fed carbon dioxide. One case in which this may readily be determined is that of alanine. Its position on the paper can be defined with reference to the radiogram. The spot is then eluted and the activity determined by counting an aliquot. The alanine content of the remaining solution is then determined colorimetrically. When this is done, the following very approximate values are obtained for the molar specific activity related to that of the starting carbon dioxide for various times of photosynthesis by *Chlorella*: 5 seconds, ~ .04; 15 seconds, ~ .1; 90 seconds, ~ .9; and 5 minutes, ~ 3.

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TECHNICAL PAPERS

Underwater Listening to the White Porpoise (*Delphinapterus leucas*)

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Recent developments in underwater acoustics have led to considerable speculation on the sounds made by cetaceans. Exclusive of those incidental to breathing or splashing at the sea surface, there is a variety of sounds which several species are known to make habitually while submerged. Published accounts allude to such sounds as heard through the air, but there seems to be no record of what can be heard by listening in the whales' own medium.

To learn more of the extent to which particular cetaceans do make underwater noises and how they sound under natural conditions on underwater listening apparatus, we wished to find an area where a single species was plentiful enough to be observed and listened to for relatively long periods. The white whale or porpoise, *Delphinapterus leucas* (Pallas), suggestively nicknamed "sea canary" (*1, 2*), seemed a promising subject and was known to occur in large numbers in the St. Lawrence estuary. As suggested by Vladykov's recent comprehensive works (*10, 11*) on this species, we found a good concentration in the lower Saguenay River in Quebec. The white porpoises were remarkably numerous, passing up and down the river in groups of various sizes throughout the day, so that we were able to listen to them for hours at a time, while watching them through field binoculars. Furthermore, no other cetaceans were observed there, although the little piked whale, *Balaenoptera acutorostrata* Lacépède, was seen in the St. Lawrence River a few miles away.

Our listening gear (a conventional underwater microphone, or hydrophone, with an amplifier) enabled us to hear over a frequency band between somewhat less than 500 and 10,000 cycles/sec, well within the normal human audible range. Strong currents, shoals, tide rips, and traffic in the St. Lawrence contributed to a noise background sufficiently high to interfere with our hearing. In the lower Saguenay the deep water (over 100 fathoms) and our good fortune in having little wind gave us the quiet essential for good listening, although there were two intervals with strong gusts of wind when the waves drowned out the sounds made by *Delphinapterus* nearby.

We found the water remarkably free of animal noise except when *Delphinapterus* were within range. Whenever we saw them we heard a variety of sounds which would become louder as the porpoises were seen coming around a bend in the river and would die away as they passed out of sight. But for the two occasions of rough water, we never sighted them without hearing them, and rarely heard them without seeing them, except after dark.

The noises which we thus ascribed to *Delphinapterus* were heard as high-pitched resonant whistles and squeals, varied with ticking and clucking sounds slightly reminiscent of a string orchestra tuning up, as well as mewing and occasional chirps. Some of the sounds were bell-like, and a few rather resembled an echo sounder. Occasionally the calls would suggest a crowd of children shouting in the distance. At times there were sharp reports, somewhat like a blow with a split bat or a slap on the water, although nothing could be seen to be striking the water in any way; perhaps this was jaw snapping, as reported for *Tursiops* by McBride (*8*, p. 25; *9*, p. 112). On two occasions we heard trilling, which quite justified the name "sea canary." This description is given with some diffidence in view of the notorious difficulty of adequately describing unfamiliar sounds. We hope to make phonographic recordings at another opportunity.

It is to be emphasized that all these sounds were made under water. We heard them only through the hydrophone, which was at depths of 60 to 90 feet; the porpoises were never nearer than about 200 yards, and often over two miles away. Mostly they passed along the far side of the river in their usual series of short dives (5–10 seconds' submergence, perhaps 50 feet of horizontal progression), but sometimes they would make unusually long dives (up to about half a mile) apparently to avoid us; in either case their calls continued uninterrupted. Axel Olsen and Léopold Boulianne, of Tadoussac, Province of Quebec, who accompanied us, said that they had previously heard whistles when *Delphinapterus* passed directly beneath their canoe, but that they had never heard such a variety of sounds as they now did over the underwater gear. Similarly, the underwater sounds heard by earlier authors (Fisher, *3, 4*; Kane, *6*; Nielsen, *2*; and others, summarized by Vladykov, *10*, pp. 121–124) may be recognized among the list of those we heard, although no single listener seems to have heard them all, perhaps because they were handicapped by listening through the air instead of through the water alone.

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[1] Contribution No. 400 from the Woods Hole Oceanographic Institution.

[2] The authors are indebted to officials of the Province of Quebec, especially to Dr. Vadim-D. Vladykov, of the Department of Marine Fisheries, for cordial advice and assistance, to Mr. Charles Frémont, General Superintendent of Game and Fisheries, and to Dr. Robert Lagueux for his hospitality at the Tadoussac Fish Hatchery.

Since fish noises predominate in other regions, it seems strange that none were identified here, except for those caused by their biting and pulling at the hydrophone. It is possible that some of the sounds might be of fish origin, but it is significant that only the bites were detected in the absence of *Delphinapterus*.

Particularly striking is the great variety of *Delphinapterus* sounds and their rapid and apparently continuous succession. This loquaciousness contrasts markedly with most terrestrial herd mammals and compares with such chatterboxes as monkeys and men. Among the Cetacea it would appear not to be limited to *Delphinapterus*, as is indicated by the continuity of related but less varied sounds heard by one of us in the presence of different porpoises in the open Atlantic, as well as those on phonograph records at the Woods Hole Oceanographic Institution which are believed to be of porpoises. The considerable difference between the sounds we heard in the presence of *Delphinapterus* and the less spectacular ones associated with *Delphinus* (Kullenberg, *7*; Fraser, *5*), *Tursiops* (McBride, *8*, p. 19; *9*, pp. 112–113), and other pelagic forms encourages us to hope that these underwater calls may be sufficiently characteristic to be helpful in distinguishing cetaceans at sea. Such listening probably will have to be carried into the supersonic range.

Only toothed whales (Odontoceti) have figured in the reports so far encountered. It would be of interest to learn of any authenticated instances of hearing underwater sounds from baleen whales. Among these, our experience with listening apparatus is limited to the solitary individuals of *Balaenoptera acuto-rostrata* mentioned earlier; we distinguished no underwater sounds even when a whale was within 300 yards.

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Colorimetric Estimation of Succinic Dehydrogenase by Triphenyltetrazolium Chloride[1]

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Methylene blue or other redox dyes are extensively used as indicators of dehydrogenases. Enzyme activities are frequently defined by the anaerobic decolorization time of a redox dye, but photometric estimation of the decolorization can be carried out in special Thunberg tubes only if the reaction mixture is not very turbid (*3*). It was found in our laboratory that triphenyltetrazolium chloride is a suitable indicator of the succinic dehydrogenase activity of tissue homogenates. The advantages of this technique are that the system does not require anaerobic conditions and that the enzyme activity can be followed quantitatively by colorimetric measurements.

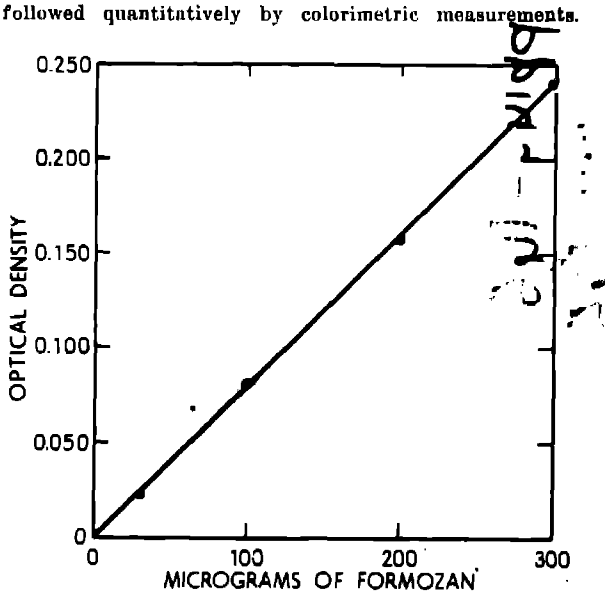

FIG. 1. Straight line relationship between the amount of reduced tetrazolium salt (formozan) and optical density ($\log I_0/I_x$).

Tissue homogenates in the presence of succinate in a buffered (pH 7.4) medium reduce the colorless tetrazolium salt to a red water-insoluble formozan. The formozan (*2*) can be easily dissolved in acetone, which, by precipitating tissue proteins, leaves a clear supernatant ready for colorimetric measurement. Under given conditions, in the absence of succinate the tissue homogenates tested do not reduce the tetrazolium salt except under strongly alkaline conditions.

If this principle is applied, the colorimetric determination of succinic dehydrogenase can be carried out according to the following procedure: Into 15-ml calibrated centrifuge tubes are pipetted 0.5 ml of 0.1 M phosphate buffer (pH 7.4), 0.5 ml of 0.2 M sodium succinate, 1.0 ml of 10% tissue homogenate (*i.e.* 0.1 to 1.0 ml of homogennte, depending on the enzyme content, made to 1.0 ml with distilled water), and lastly 1.0 ml of freshly prepared 0.1% triphenyltetrazolium chloride solution. After shaking, the tubes are placed in a constant temperature bath at 38° C for a period of 15 to 30 min. Immediately after removal of the tubes from the bath, 7 ml of acetone are added and the tubes are stoppered and shaken vigorously. The precipitate is then centrifuged, and the clear supernatants are drawn off for the determination of optical density. The color is stable for several hours and can be measured by the Klett photometer using a 420 filter. There is a linear correlation between the amount of dye and optical density (log I_0/I_x) in the range between 20 and 300 µg. To obtain a calibration curve, varying amounts (20 to 300 µg) of tetrazolium salt are reduced by a few crystals of sodium hydrosulfite in the system as described (Fig. 1). Furthermore, the amount of dye measured by optical density is a linear function of the amount of enzyme present (Fig. 2). The rate of reduction of the dye gives a curve resembling that of most enzymatic reactions. During the first 30 to 40 minutes the curve is approximately linear. Under anaerobic conditions (nitrogen) the rate of reaction is initially greater, while tending to decrease more rapidly (Fig. 3).

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[1] This investigation was supported by a grant from the Office of Naval Research, N6ORI-20, Task Order #11.

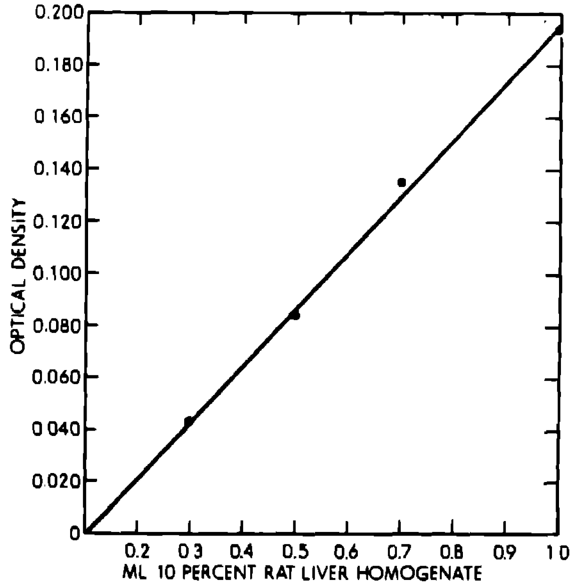

FIG. 2. Straight line correlation between the amount of enzyme (rat liver homogenate) and the amount of reduced tetrazolium salt, as measured by optical density. Time of incubation, 10 min; temperature, 38° C.

In view of these findings it is quite simple to determine quantitatively the succinic dehydrogenase activity of tissue homogenates. The enzyme activity of various tissues may be expressed in terms of micrograms of dye reduced in 10 minutes by 1 milligram of tissue; however, it is necessary to take into account the unequal adsorption of the dye by equivalent amounts of different tissues. Consequently, two controls are run with the unknown; the first contains no succinate and serves as a tissue blank, while the second also contains no succinate but a given amount, viz., 100 µg, of the tetrazolium chloride which is reduced by sodium hydrosulfite. The latter is the reference standard for a specific tissue. The experimental tube contains all the constituents. Typical experimental data obtained with 10% homogenates of rat kidney, liver, brain, heart, and testis are presented in Table 1.

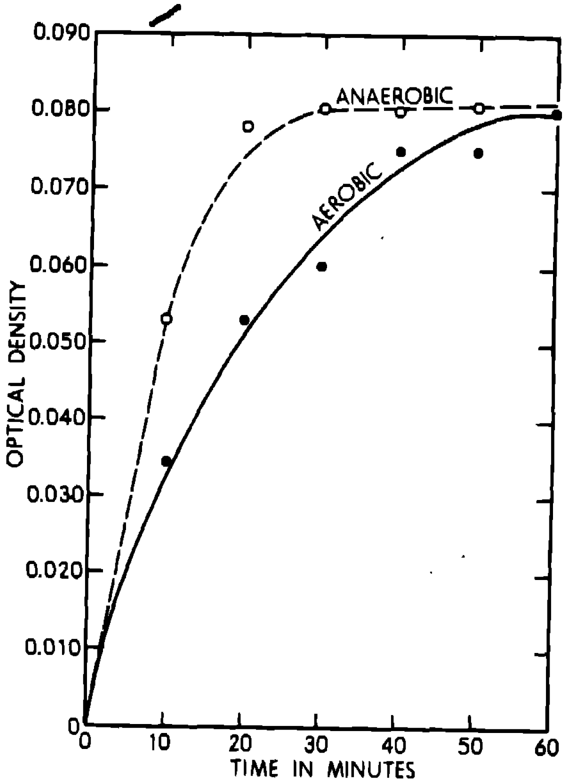

FIG. 3. Comparison between the rate of reduction of the tetrazolium salt by 0.25 ml of 10% rat liver homogenate under aerobic and anaerobic (N_2) conditions.

This method can be used in the study of enzyme inhibitors. Sodium malonate (0.5 ml of 0.1 M solution) produces a 75% inhibition of the succinic dehydrogenase activity of rat liver homogenate (0.5 ml of 10% homogenate); ethyl urethane (0.5 ml of 2% solution), 46% inhibition. Cyanide (1%) on the other hand causes no inhibition. Triphenyltetrazolium chloride does not interfere with succinate oxidation by tissue homogenates either

TABLE 1

Tissue	µg of dye reduced/ mg of tissue*/10 min
Kidney	1.72
Liver	1.56
Brain	1.00
Heart muscle	0.75
Testis	0.43

* Wet weight.

in the absence or in the presence of added cytochrome C, as measured in the Warburg apparatus (*1*).

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Determination of Radioactive Content of Rocks by Means of Geiger-Müller Counters

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Geiger-Müller counters are widely used in the search for radioactive substances, but their use for immediate quantitative determination has not been elaborated. During a survey of the Velence Mountains in Hungary we have developed a direct approximating method.

Brass G-M counters of the self-quenching type (45 mm in diameter, 88 mm in length and 1.8 mm in wall thickness), filled with 100 mm argon and 10 mm alcohol vapor, were used in connection with all battery amplifiers. The soft components of the γ-radiation were absorbed by a 2 mm-lead shield. In this way only the known penetrating γ-components of the known radioactive bodies (uranium, thorium, their decay products, and potassium) could reach the counter.

In most cases the counter was placed touching the rock wall to be investigated, but in one instance, we drove a bore, 5 cm in diameter and 50 cm deep, into the granite wall and placed the counter within. The counting rate (number of impulses/min) was determined and compared with the counting rate of the cosmic radiation, the last amounting to 40/min. We subtracted this value from the observed total counting rate, and divided the remaining rock-activity counting rate by this factor. We observed that the counting rate was about 6 times higher in the bore and 2–3 times higher immediately at the wall than the cosmic radiation. The activity of the rocks can be expressed approximately by this factor, and this kind of expression is, within some limits, independent of the counter dimensions. It can be used for comparison of measurements made by various brass counters. However, it is not independent of the material of the counter, because the γ-sensitivity of a G-M counter depends upon the atomic weight of its substance. As is known, the intensity of the cosmic radiation depends upon the geographical latitude. In this case it amounted to about 1 impulse/min · cm² of maximum square area of the counter (length × diameter).

The observed γ-radiation of rocks may originate from K, U, and Th, and their decay products in equilibrium. ThC″, RaB + C and K are the sources of the hard γ-radiations, which affect the counter under such conditions. Softer components may have a minor part only, for they are absorbed by the lead shield, and the sensitivity of a brass counter is small for soft γ-rays.

Now it must be realized, that the direct determination of the proportion of the existing radioactive substances to each other in the rock is hardly possible with a G-M counter without any chemical separation. It is possible, however, to determine the total radioactivity of the rocks expressing it in Th-γ-equivalents, as measured by a brass G-M counter behind a 2-mm lead shield. We achieved it in the following way: It is possible to calculate the total amount of the hard γ-radiation that reaches the counter from the surrounding rock substance. In Fig. 1 we have taken the center of our coordinate system as the middle of the counter in the bore. (The counter may be regarded as small in comparison with the surrounding rock masses.) A small volume, *dv*, of the rock containing *c* g-Th-equivalents of radioactive substance/cm³ rock, will send a penetrating γ-radiation from *r* distance to the counter, giving the counting rate, *dJ*. It is obvious that $dJ = cA\,dv/r^2$, where A is the sensitivity of the given counter, that is, the rate of counting when 1 g Th (in radioactive equilibrium) is placed 1 cm from the counter.

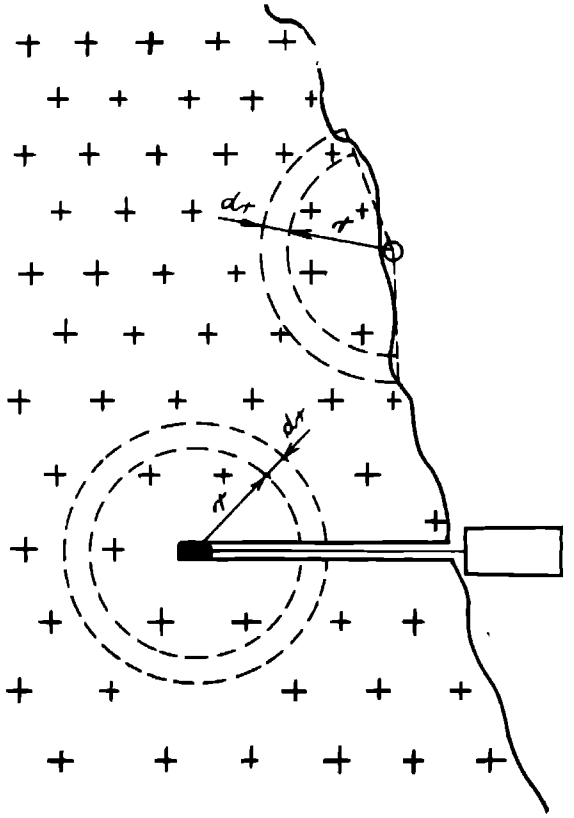

FIG. 1. Determination of Th and U concentration in rocks by a G-M counter tube.

Now we must take into account the self-absorption of the γ-radiation within the rock substance itself. The γ-quanta traverse the distance r in rock and not in space, thus the counting rate is diminished by a factor of $e^{-\mu r}$, where μ is the absorption coefficient, expressed in cm^{-1}. For simplicity of calculation of the volume element, dv, we choose the spherical shell of radius r; the thickness of it being dr: $dv = 4\pi r^2 dr$. Taking the self-absorption into account, the counting rate is

$$dJ = \frac{cA4\pi r^2 e^{-\mu r}\,dr}{r^2} = 4\pi cAe^{-\mu r}\,dr.$$

We take the integral over the infinite space filled with rock and obtain the total counting rate:

$$J = \frac{4\pi cA}{\mu}.$$

We are actually interested in the concentration c, which is expressed here in g/cm^3. It is more usual to express it c' in g/g of rock, if ρ is the specific density of the rock in $g/cm.^3$

$$c' = \frac{c}{\rho} = \frac{\mu J}{4\pi A\rho}.$$

The absorption coefficient above is expressed in cm^{-1} and refers to the rock substance. It can be determined experimentally by using a known amount (about 10–50 g) of old Th-compound, or we can calculate it reliably, knowing its value in lead, $\mu_{Pb} = 0.46\ cm^{-1}$ (with 2 mm of lead). By dividing it by the specific density of lead we obtain the so-called mass-absorption coefficient; multiplying this by the density of the rock, we obtain the absorption coefficient in the rock

$$\mu = \frac{\mu_{Pb}}{11.3}\rho$$

If the absorption coefficient in lead is substituted, the formula takes a simpler form, in which the specific density of the rock does not play any role:

$$c' = \frac{\mu_{Pb}J}{4\pi 11.3A}$$

The counter sensitivity, *A*, was determined experimentally by placing 10 g of old ThO_2 at 30 cm distance from the center of the counter. For our brass counter its value was $4.8 \cdot 10^2$ impulses/g of Th · min.

We calibrated the same counter in U-equivalents as well, using instead of U, about 0.01 mc of radium in radioactive equilibrium. As the penetrating γ-radiation originates from RaB and RaC, the γ-radiations of the decay products between U and Ra can be neglected (1 g of Ra is equivalent to $3 \cdot 10^6$ g of U in radioactive equilibrium). The value for μ_{Pb} is known to be 0.53 cm^{-1} in lead. We obtained a value for *A* of $9.3 \cdot 10^6$ impulses/min · g of U at 1 cm distance from the given counter.

As can be seen, the estimation gave for the Th-U equivalent a value of 1.9, that is, 1.9 g of Th gives, in this brass counter, the same rate of counting as 1 g U (in radioactive equilibrium with their decay products).

The method outlined above was checked experimentally by our measurements on a granite wall near the village of Velence in Hungary. We obtained, with the counter in the bore, $12 \cdot 10^{-5}$ g-Th-equivalents/g of granite for the total concentration of the radioactive bodies. Careful laboratory tests were carried out later on a sample taken from the same granite wall. It was dissolved completely and the equilibrium of radon and thoron content determined separately, by means of an ionization emanometer. These measurements yielded $4.2 \cdot 10^{-5}$ g of Th and $0.87 \cdot 10^{-5}$ g of U/g of granite. The granite of these mountains contains about 3.9% K as determined by A. Vendl (*5*). The K-U equivalent was determined by F. Behounek (*1*) and more recently by E. Gleditsch and T. Graf (*2*). The γ-radiation of K is equivalent to 4.10^{-4} g of U/g of K. Expressing the U and K content of the granite in Th-equivalents, we obtain good agreement of the two entirely different methods of determination. The difference lies in the fact that the counter gives a mean value for the concentration within a sphere of a diameter of about 60 cm surrounding the bore, but the emanometric measurements indicate the activity of the dissolved sample to be about 4 g of granite.

Now in a practical search for radioactive content, higher concentrations must be considered. The K content can be neglected. Any commercial G-M counter tube can be calibrated in the way outlined above by the use of about 10 g of old Th compound and/or about 0.01 mc, calibrated Ra source in equilibrium. With a brass counter, not differing too much from the dimensions above, calibration is not essential. One may use our calibration, expressed by the approximate numerical formula:

$$c = \frac{0.46 \cdot 36.4J}{4\pi LD4.8 \cdot 10^3 \cdot 11.3} = 2.4 \cdot 10^{-5}\frac{J}{LD}$$

where c is the concentration in g-Th-equivalents/g of rock; *J*, the counting rate (in min); *L* the length; and *D* the diameter (in cm) of the brass cathode of the counter tube. Similarly, we obtain the concentration in g-U-equivalents/g of rock by the approximate numerical formula:

$$c = 1.4 \cdot 10^{-5}\frac{J}{LD}$$

If the measurements are made without use of the bore, the counter is put as near as possible to the wall, and there is a loss of 50% or more in the counting rate, depending upon the geometry. The accuracy is reduced by the fact that the geometry is not so well defined as in the case of the bore, but the formula can be used, approximately, by multiplying the counting rate by a correction factor of about 2–2.2.

Further, the use of the following roughly approximating simple rule may be suggested for uranium explorers when extended territories must be surveyed within a short time: If a G-M counter of any commercial dimensions, shielded by 2 mm of lead, is placed against the rock wall and the observed counting rate (minus cosmic radiation) is x times the rate of cosmic radiation for the same counter, then the average U concentration in the rock is x times 25 g U/metric ton (1,000 kg) of rock.

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An Ostreodynamometer for Studying the Activities Inside the Shell of Bivalve Mollusks[1]

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In conducting investigations on the effects of industrial pollution on oysters, it was considered necessary to develop an instrument capable of detecting movements within the shell without interfering with an oyster's normal activities.

The ideal method of recording cardiac, pericardial, visceral, or branchial activity should continuously yield data on the influence of chemical agents on the nature of activity in various tissues and organs. Thus, several indices could be established and compared to the activities occurring in a normal sea-water environment.

The instrument which we have devised (Fig. 1) records such activities electrically. Shell movements are recorded synchronously by a mechanical system. The principle involves the application of the carrier system of electronic amplification to direct recording, as used in strain-gage techniques. The key to the method is the specially devised pickup by which the imperceptible movements of a probe can unbalance a Wheatstone bridge.

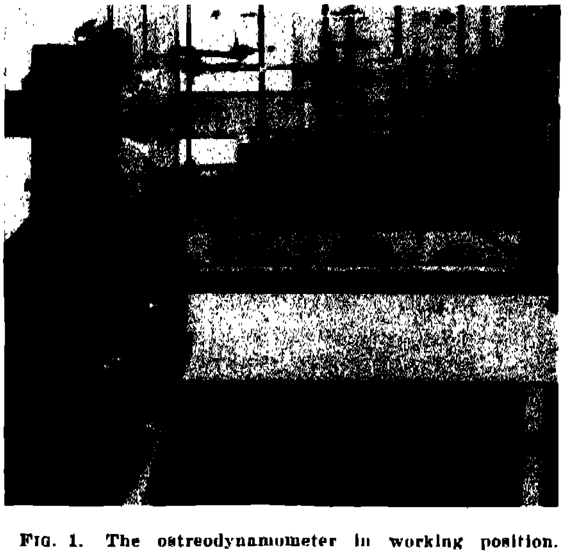

FIG. 1. The ostreodynamometer in working position. Power supply and amplifier (left); pickup device and salt-water distribution tanks (right).

Prior to the actual operation of the instrument, a small hole (1.5 mm) is carefully drilled through the valve of the oyster at the approximate position of the organ to be studied. The oyster is then allowed to recover until the thin prenacreous membrane has been formed. A natural membrane is thus utilized for the transmission of organ pulsations, e.g. cardiac, to a counterbalanced probe resting on the membrane.

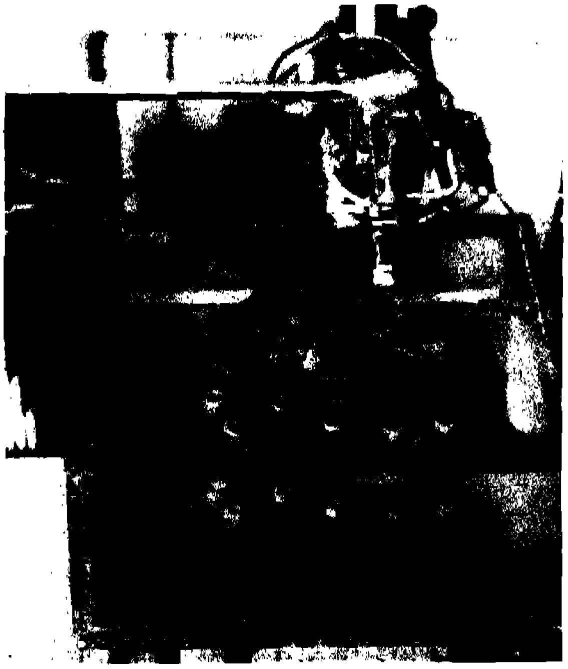

FIG. 2

The pickup mechanism in operation is shown in Fig. 2. The probe consists of an aluminum rod to which is attached a 10-mm fragment of silica steel and which, in turn, is counterbalanced by a simple lever. The steel fragment is inserted midway between the core of the detector coils and is equal in length to the thickness of one coil.

Two 6,000-ohm coils, adjacently connected, serve as the basis for the detection of kinetic activity. The fragment of steel transmits the mechanical movements of the probe. The coils are connected in a conventional Wheatstone bridge circuit in such a manner that, as the impedance of one increases, the impedance of the other decreases. The over-all current in the bridge circuit is thus held constant at the generator position, but variations in voltage are present at the detector. Since the impedance of each coil varies with the position of the probe, its fluctuations caused by the organ pulsations are converted into corresponding fluctuations of impedance. Since the current through the coils is constant, in accordance with Ohm's law, there is a fluctuation in voltage at the output of the bridge. This variation in voltage is proportional to the amount of movement of the probe.

Because the coils are adjacently connected, they cancel out stray magnetic interference and changes in impedance caused by variations in temperature.

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[1] This instrument is being used at the laboratory of the U. S. Fish and Wildlife Service, Pensacola, Florida, in space allocated to the State of Louisiana for the purpose of conducting independent investigations.

A well-regulated power supply and a 1,000-cycle oscillator are constructed on one chassis; a second chassis contains the amplifier and the detecting system. The power supply itself is a conventional full-wave unit with choke input filtering, anti-jitter type of voltage regulator, a Wein bridge-type oscillator, and a single-tube buffer amplifier, coupled to the input position of the Wheatstone bridge. The output of the bridge is connected to the input of a three-stage voltage amplifier, with a degenerative type of step gain control. This degeneration control serves to regulate the amount of deflection on the recording pens per kinetic unit of the bivalve. The voltage at the input of the amplifiers consists of a 1,000-cycle "amplitude modulated" audio note, with its amplitude varying in proportion to the internal movements of the oyster. Amplitude variations are removed by simple detection with dry disk rectifiers, whose output is sufficient to operate the recorder.

The recorders are the Esterline-Angus type with multiple ranges of 1, 5, and 10 ma. At these values the recorder requires a 2-v emf. This is derived from the detector through the final tube of the power amplifier. In series with the recorder is the monitor meter which is used to balance the bridge and bring the output to a value within the range of the recorder.

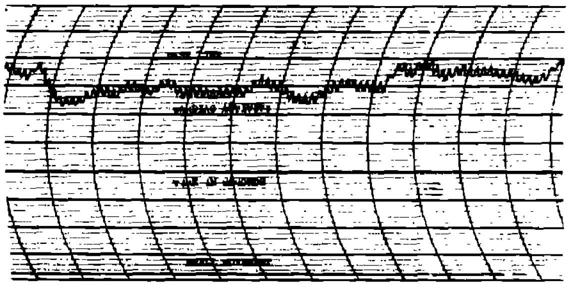

FIG. 3. An ostreodynagraph. The oyster shell is open. Total time of sample record, 3 min.

In operation, the probe and coils are adjusted to fit the individual oyster (Fig. 2). The probe is adjusted so that the balance is slightly in favor of that part resting on the prenacreous membrane. The sensitivity of the pickup mechanism permits detection of slight rotational movements as well as the vertical movements of the probe.

The pen of the recorder can be controlled by the balance unit on the amplifier, allowing a base line to be set in any position. The amplitude of the recording can be regulated by varying the feedback in the amplifier or by varying the milliamperage range of the recorder. The bridge is operated slightly off balance so that the entire motion of a particular organ can be recorded without distortion (Fig. 3).

This instrument has been named an ostreodynamometer (ostreo—oyster; dynamometer—measurement of force). The records obtained are ostreodynagraphs.[2]

The range of applications of the ostreodynamometer will have to be determined by use. Various types of strain gages, capillary columns, resistance pickups, or any conversion element changing to electrical impedance, can be substituted for the detector coils.

Its value at the present time lies in the fact that for the first time the encumbrances of the shells have been circumvented, making it possible to study the physiological processes of mollusks with a minimum of injury.

A detailed report of the construction of this unit, including wiring diagrams and drawings, will be made in another journal.

The Osmotic Activities of Sodium Penicillins F, G, K, and X[1]

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By means of surface tension measurements in 1947 Hauser, Philips and Philips (*2*) found that solutions of sodium penicillin G have a high capillary activity, a fact which led them to believe that such solutions are colloidal sols and not true solutions. Woodbury and Rosenblum, however, (*7*), have made conductivity measurements over a range of concentrations of sodium penicillin G and found that the salt behaves as a completely dissociated electrolyte of the 1:1 valence type, with possible deviations due to ion size and interactions. In 1948 Kumbler and Alpen (*4*), employing both du Noüy's precision tensiometer and the capillary rise method, carried out surface tension measurements on aqueous solutions of crystalline sodium penicillin G and crystalline potassium penicillin G and found that solutions of penicillin G have a surface tension differing only little from that of water. Therefore, the solutions must be true solutions and not colloidal sols.

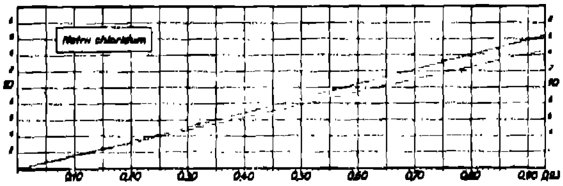

FIG. 1. Freezing point depression in °C (abscissa); concentration in 0.1 per cent (ordinate).

In the following we shall give an account of some experiments on the osmotic activity of penicillin solutions using relative vapor-pressure measurements, in order to throw more light on the subject by means of a third method of measurement, in addition to the two referred to above. In 1946 we examined the osmotic activity of the commercial penicillin preparations then obtainable, varying widely as they did in purity; pure sodium penicillin G was not available to us at that time (*5*). We had no doubt that a solution of sodium penicillin must be a true solution rather than a sol and would consequently have measurable osmotic activity. Some relative vapor-pressure measurements of pure crystalline sodium penicillins F, G, K, and X were made as follows.

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[2] Name suggested by S. R. M. Reynolds, *et al.* *Science*, 1947, **106**, 427.

[1] We wish to express our gratitude to the Antibiotic Study Section of the National Institutes of Health, U. S. Public Health Service, for the supply of crystalline penicillins F, G, K, and X used in these studies.

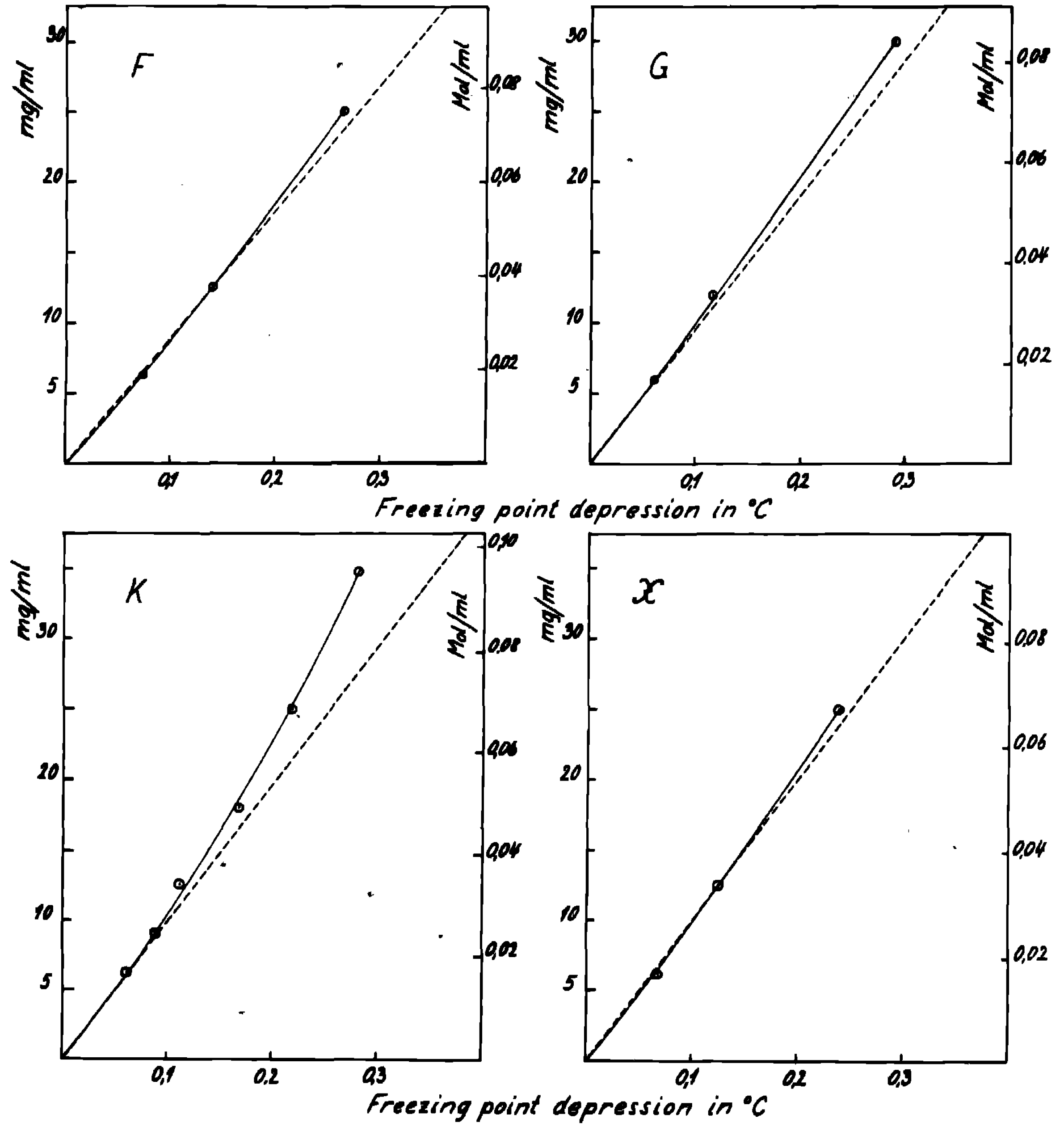

FIG. 2. Freezing point depression of aqueous solutions of sodium penicillins F, G, K, and X.

For determining the relative vapor pressure of the solutions we employed Baldes' (*1*) modification of the method described by Hill (*3*). The apparatus consisted of a thermoelement with two small eye-shaped solderings capable of being enclosed in a small metal container, the walls of which are covered with filter paper.

For taking a measurement a small drop of the solution to be tested is placed in one eye and a similar drop of a standard solution in the other; the filter paper on the wall is also moistened with the standard solution. For the standard solution we take whichever concentration of a series of sodium chloride solutions (0–0.5, 1.0, 1.5 to 15.0%) is presumed to have a vapor pressure of the same order as that of the solution to be tested. The thermoelement is then placed in a Dewar flask with water, to ensure that the measurements can proceed at a constant temperature, and connected with a sensitive galvanoscope. If the two drops represent solutions of different osmotic pressures, evaporation from the drops will differ. That having the lower osmotic pressure will evaporate more rapidly and thus become cooler than the other. The difference in the temperatures will generate a thermoelectric force which will register on the galvanoscope. By these measurements we then find the two successive standard solutions between which the vapor pressure of the test solution lies, and, with the aid of the registration values, we can by interpolation calculate the sodium chloride concentration that gives the same vapor pressure as the test solution. From this concentration, by employing the relation between sodium chloride concentration and freezing point depression (see Fig. 1) previously described (*6*), we can find the freezing point depression which the particular solution would give. The uncertainty in this determination is about ± 5%.

From the sodium salts of the pencillins we prepared aqueous solutions with 6.25–36.0 mg/ml solution.

In Fig. 2 the results found experimentally and converted to freezing point depressions are plotted as small circles. The continuous curves in the figure are drawn by transferring point by point the straight lines connecting the circles in a double logarithmic coordinate system to the arciform curves seen in the arithmetic system employed in Fig. 2. The relation between the concentration and the molar freezing point depression, calculated by Raoult's law, is shown in stippled curves.

The osmotic coefficients for 0.05 molar solutions of sodium penicillins F, G, K and X are as follows: F, 0.98; G, 0.94; K, 0.88; and X, 0.97. It will be seen that the osmotic coefficients for pencillins F, G, and X amount to 0.94–0.98, which corresponds to that for a 0.05 molar solution of sodium chloride. In a 0.05 molar aqueous solution of sodium penicillin K the osmotic coefficient is lower, 0.88, corresponding to the osmotic coefficient in a 0.05 molar solution of loboline-hydrochloride. The low osmotic coefficient shown by the K penicillin is possibly due to the long heptyl chain in this molecule.

Not only the high value found for the osmotic coefficient, but also the fact that the osmotic coefficients of the sodium penicillins are of the same order as other dissociated electrolytes of the 1:1 valence type in similar concentrations, shows that these are true solutions.

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(*Continued from page 139.*)

movements of the limbs, causing the horse to roll over and over, were precisely those which are to be observed in the death struggle of a rabbit shot through the cerebellum."

D'Arcy Thompson was made Companion of the Bath in 1898 during Queen Victoria's reign, elected to the Royal Society in 1916, created knight in 1937. He received the degrees of D.Litt. (Cambridge), Hon. D.Sc. (Dublin and Witwaterstrand) and LL.D. (Aberdeen and Edinburgh). He was vice president (1931–38) and president (1934–39) of the Royal Society of Edinburgh. He was awarded the Darwin Medal in 1946. He was foreign correspondent and honorary member of a number of learned societies.

One spring morning in Paris, walking on the crowded boulevard, I heard my name called and saw a towering figure with massive sculptured head and long flowing beard, dart out from the tables of a sidewalk cafe. He greeted my wife, seized our hands, and pushed us into chairs. Seated opposite us, Sir D'Arcy, with no further ceremony, began to read to us a funeral oration that he was working on!

His last visit to this country was in 1936 on the occasion of his delivering six Lowell Institute Lectures in Boston, 79 years after his father had been invited to the same Institute. The subject matter of Sir D'Arcy's lectures is included in his book on Growth and Form. On his leaving New York for Scotland I went to see him off and found him on board with Leo Hendrik Baekeland, of Columbia University, the inventor of Bakelite. During the conversation, Professor Baekeland, who was 74 years of age at the time and only 3 years younger than Sir D'Arcy, remarked on my callow youthfulness in the presence of two septuagenarians. Sir D'Arcy, gazing at the magnificent panorama of New York from the Jersey shore said: "My hope is that I shall die young!"

Happily, he maintained his "youth" and at the age of 86 accepted an invitation to be one of four delegates to the Indian Scientific Congress in Delhi. He had been extremely well and was full of enthusiasm at the thought of ten days in Egypt before flying to India. But on his return the wear and tear of the journey had so depleted his strength that he was unable to recuperate from a protracted siege of pneumonia. He died June 21, 1948.

Sir D'Arcy was a man of the world, at home everywhere and with all conditions of people. He was a man of deep conservatism but with a quality of delightfully disarming revolt against the conventions. He had an inexhaustible sense of humor with touches of the oratorical, and was always an interesting companion and a solid friend.

Book Reviews

Radioactive indicators: their application in biochemistry, animal physiology, and pathology. George Hevesy. New York-London: Interscience, 1948. Pp. xvi + 556. (Illustrated.) $10.00.

The first application of tracer methods in biological research was made by Prof. Hevesy in 1923. With this book Prof. Hevesey—whose achievements as both initiator and foremost exponent of the use of tracer methods in many aspects of physiology and biochemistry were recognized in 1943 with the award of the Nobel Prize in chemistry—has marked the 25th anniversary of his fathering of tracer methodology. The subject matter is organized meticulously to cover tracer researches in animal physiology, biochemistry and pathology and is presented with characteristic lucidity. It has been announced that a volume dealing with plant physiology is in preparation.

Topics treated most thoroughly relate to the interest of Hevesy and his collaborators in investigations of whole organisms. There is an amazingly complete coverage of literature dealing with absorption, retention, turnover, and excretion of various metabolites, particularly those involving the mineral components phosphorus, iodine, and iron. Much data previously available only in journals difficult to obtain are made easily accessible for the first time.

The mere inclusion of such a wealth of material (over 900 references are cited) has involved an enormous amount of work, since no small fraction of the data undoubtedly required considerable reworking for adequate treatment. Insofar as is possible, an integrated presentation of these data has been undertaken. Extensive treatment of the fundamental concepts involved in tracer work, however, has not been possible. The over-all result is a volume with an appearance perhaps more of a compendium or reference than a text. In any case Dr. Hevesy has performed an extremely important service in bringing a measure of order into the chaos of literature dealing with tracer researches on absorption and turnover.

The merits of this treatise might be enhanced by a few shifts in emphasis. Thus, although detailed descriptions of mechanical devices, such as those used for automatic counting, are provided, fundamental phenomena and considerations relating to functioning of assay instrumentation are accorded either brief or only passing mention. For example, the correction for nonlinearity of response of a G-M counter at high counting rates is remarked only in one brief sentence in small print (p. 52). The statistical nature of G-M counter determinations is treated in a single page. The discussions of various formulas relating to turnover calculations should also have been extended.

There is evidence of very careful proofreading. Grammatical errors, as well as errors in references cited, are surprisingly few for a first edition. Tables and figures are clearly reproduced. An added feature is the inclusion of an isotope chart as compiled by E. Segrè.

MARTIN D. KAMEN

Washington University

Pulse generators. G. N. Glaso and J. V. Lebacqz. (Eds.) New York-London: McGraw-Hill, 1948. Pp. xiv + 741. (Illustrated.) $9.00.

This book is volume 5 of the excellent MIT Radiation Laboratory Series of 28 volumes describing radar and radar techniques. While the title is probably reasonably apt for those who have not been in the radar field, most radar workers would have chosen "Magnetron Modulators" as a title. Virtually everything in the book relates to current-voltage pulses of duration and magnitude found convenient for radar magnetrons during the war, and devices for producing such were usually called modulators.

Specifically, the range covered in this book is from about .03 to 5 microseconds' duration, 1 to 60 kv on voltage and from 100 watts to 20 megawatts on power. This material is covered in 15 chapters which are broken up into three groups. In the first group is "The Hard Tube Pulser," which uses a vacuum tube as a switch to connect and disconnect an energy storage device (usually a simple condenser) and the load. The second group considers "The Line-Type Pulser," in which an artificial transmission line not only stores the energy but also determines the pulse shape on being connected to the load by means of a spark gap or hydrogen thyratron. The third group of chapters presents "Pulse Transformers." There are also appendices on "Measurement Techniques" and "Pulse Duration and Amplitude."

As a whole the book is very well done and the present reviewer has found it useful, interesting, and informative. Especially noteworthy is the fact that, in spite of the rather large number of contributing authors (13), there appear to be neither large gaps nor duplications.

On the other hand, much of the section on pulse transformers has been spoiled, for the present reviewer, by the author's "explanation" of many formulae by a rather nebulous analogy between thermodynamics, or possibly statistical mechanics, and transformers. This analogy is perhaps most clearly stated on page 501, and the fact that this assigns two degrees of freedom to a single mesh circuit does not inspire confidence. The analog is used to "explain" a result usually derived by the maximum minimum methods of first year calculus. In fact, all the results the reviewer has checked seem to be correct, but because of the "thermodynamic" reasoning, the reviewer will not feel that the statements in these chapters are reliable for quick reference until he has verified them.

WILLIAM W. HANSEN

Stanford University

NEWS and Notes

Serge Korff, physicist at New York University College of Engineering, left for Europe on January 25 to continue his studies of cosmic rays. He will compare his test data with those of scientists at laboratories in Italy, France, Switzerland, Denmark, Sweden, and England to determine whether cosmic rays differ in intensity at various geographic locations.

Henry W. Fowler, curator of Fishes in the Academy of Natural Sciences of Philadelphia, is making a 4-month study of the fresh water fishes of Colombia, particularly those in the headwaters of the Atrato, Magdalena-Cauca, Orinoco, and Amazon Rivers. His expedition is supported by a grant from the American Philosophical Society.

Maurice M. Shapiro, physicist at Oak Ridge National Laboratory, has been appointed head of the section on heavy-particle physics in the Nucleonics Division of the Naval Research Laboratory, Washington, D. C.

Appointment of **Harvey A. Neville** as dean of the Lehigh University Graduate School and **Robert P. More** as associate dean of the College of Arts and Science was recently announced. Both appointments will become effective July 1.

Arthur B. Lamb, of Harvard University, will retire from the editorship of the *Journal of the American Chemical Society* at the end of this year. His successor will be W. Albert Noyes, Jr., of the University of Rochester, son of the editor whom Dr. Lamb succeeded in 1918. Both Dr. Lamb and Dr. Noyes are former presidents of the Society. Dr. Lamb will continue to serve the journal as consulting editor.

R. Lee Clark, Jr., director of the University of Texas M. D. Anderson Hospital for Cancer Research, has been elected to the Cancer Committee of the American College of Surgeons.

Roy P. Forster, professor of zoology at Dartmouth College, left for Europe January 27 to spend several months visiting universities and biological laboratories. The remainder of his sabbatical leave will be spent in research on the energetics of cellular transport in renal tubules at the Bermuda Biological Station for Research and at the Mount Desert Island Biological Laboratory.

Mariafranca Carpaneda, assistant professor of biology at Quincy College, Quincy, Illinois, is returning to Milan, Italy, after a year and 4 months of teaching and research in the U. S. She plans to continue research on *Chlorella* with a chemical antibiotics producer there.

E. C. Hamblen, professor of endocrinology in the Duke University School of Medicine, is on a 3-week lecture tour of western cities. In Los Angeles, he will present a course at the Obstetrical and Gynecological Postgraduate Assembly of Southern California February 14–19 and give an address at the College of Medical Evangelists. From there he will go to Oklahoma City to participate in postgraduate courses on endocrinology. The final lecture will be given in Chicago February 23, where he is scheduled to present the annual Bacon lecture in obstetrics and gynecology at the University of Illinois School of Medicine.

Florence S. Tabor, acting dean of the School of Home Economics in Pratt Institute since the resignation of **Joan M. Rock** in 1943, has been made dean, effective February 1.

Visitors to U. S.

B. R. Seth, on leave of absence as head of the Department of Mathematics of Hindu College, New Delhi, India, has joined the Iowa State College staff for the calendar year 1949. He is teaching courses in theory of elasticity and theoretical hydrodynamics, while assisting in a seminar on research in applied mathematics. Dr. Seth will participate in the 3rd Annual Symposium of Applied Mathematics at Ann Arbor, Michigan, next June.

Erik Tetens Nielsen, insect physiologist of Pilehuset Laboratory, Denmark, and research associate, University of Copenhagen, has begun a 6-month study of the ecology of Florida insects at the Archbold Biological Station, Lake Placid, Florida. Dr. Neilsen, assisted by Mrs. Neilsen, is working in this country under the auspices of Swarthmore College. His present program is concerned with the migration of butterflies.

Grants and Awards

Research Corporation has announced a new installment of grants totaling nearly $250,000. These first grants of 1949 were approved by the Board of Directors at their recent annual meeting in New York. At the same time, announcement was made of the 1949 recipients of the annual Research Corporation Scientific Awards. They are Bruno Rossi, professor of physics at the Massachusetts Institute of Technology, and Henry Eyring, dean of the University of Utah Graduate School.

Union College, Schenectady, New York, has received a gift of $150,000 from Frank Bailey, of New York City, to establish the Frank and Mary Louise Bailey professorship of physics. Vladimir Rojansky, professor of physics at Union College since 1930, has been named to the new professorship.

The Ohio State University Development Fund has received two gifts totaling $10,000: a grant of $7,500 by the Edward Orton, Jr., Ceramic Foundation to the fellowship endowment fund, and another of $2,500 by the Illuminating Engineering Society Research Fund to finance research in the School of Optometry.

The Marine Biological Laboratory at Woods Hole, Massachusetts, has been granted $150,000 by the Rockefeller Foundation to renovate Old Main. A basement, to be constructed this spring under the entire building, will contain research laboratories, dark rooms, cold rooms, and storage space. The Foundation has also donated $100,000 for the general support of the Laboratory.

Fellowships

A 6-week General Electric Science Fellowship Program has been announced by officials of Union College and Case Institute of Technology. The study program is open to 100 science teachers to be selected on a competitive basis from 19 northeastern states and the District of Columbia. Applications must be submitted before *April 1* to Elmer Hutchisson, Case Institute of Technology, Cleveland 6, Ohio.

Smith College announces the following fellowship and scholarship awards available in 1949–50 to qualified women students for graduate work in scientific fields: 2 or more teaching fellowships each in bacteriology, botany, chemistry, geology, physics, psychology, and zoology, carrying a stipend of $900 for the first year and $1,000 for the second year, with remission of tuition fees; research fellowships, carrying stipends dependent upon the contract involved, in genetics and physics; and 7 trustee fellowships (giving tuition and residence) and 4 trustee scholarships (giving tuition only) for work in any college department (several of these will be awarded to science students). Full information and application blanks (to be submitted on or before *March 1*) may be obtained from Florence E. Young, Graduate Office, Smith College, Northampton, Massachusetts.

Colleges and Universities

The California Institute of Technology has completed its underground laboratory annex, combining facilities for housing experimental animals and for research in biology and biochemistry. Work to be carried on in the new $150,000 building will include research in immunochemistry, genetics and immunology, cancer prophylaxis or therapy, pneumococcus studies, specificity of sexual fertilization, and neurophysiology.

The Department of Microbiology of **New York University College of Medicine** announces an intensive course in the theories and techniques of virus research to be given March 21–June 3. This full time course will include lectures, laboratory work, and discussion. Credit for two full courses will be given by the Graduate School of the University. Because the number of students is limited to 12, early publication is recommended. Further information may be obtained from the Department of Microbiology, 477 First Avenue, New York 16, N. Y.

Fundamental problems of growth and malignancy are the subject of a series of meetings being presented by the Department of Pathology, College of Medicine of the **University of Vermont and State Agricultural College.** Speakers at forthcoming meetings, which will be held in the Fleming Museum at 8:00 p.m., are as follows: February 16, W. U. Gardner, Department of Anatomy, Yale University School of Medicine; March 3, Leon O. Jacobson, Billings Hospital, University of Chicago College of Medicine; March 24, M. Demerec, Carnegie Institution of Washington, Department of Genetics, Cold Spring Harbor, Long Island; April 7, Harold F. Blum, National Cancer Institute and Princeton University; May 5, T. M. Sonneborn, Department of Zoology, University of Indiana; June 2, C. P. Rhoads, Memorial Hospital and Sloane-Kettering Institute for Cancer Research.

Industrial Laboratories

Elvin H. Killheffer, of the **Du Pont Company Development Department,** Wilmington, Delaware, has retired after 29 years. An authority on tariffs, Dr. Killheffer was a member of the U. S. delegation to the United Nations Conference on Trade and Employment at Havana in 1947.

The Westinghouse Electric Corporation has made 3 appointments in its new Atomic Power Division. The men are Philip N. Ross, assistant director of research; E. L. Kuno, assistant to the division manager; and L. C. Mechling, Jr., works engineer.

Meetings and Elections

The National Malaria Society held its annual meeting conjointly with the American Society of Tropical Medicine, the American Academy of Tropical Medicine, and the American Society of Parasitologists in New Orleans, December 5–9, 1948, and elected the following officers for 1949: president, Wendell Gingrich, Galveston, Texas; president-elect, Paul F. Russell, New York City; vice president, Ernest Carroll Faust, New Orleans; director for a 3-year term, H. W. Van Hovenberg, Mt. Pleasant, Texas; and editor, Frederick L. Knowles, Memphis, Tennessee. Martin D. Young, of Columbia, South Carolina, continues as secretary-treasurer. **The American Academy of Tropical Medicine** also elected its 1949 officers: president, Lowell T. Coggeshall, University of Chicago; vice president, Ernest Carroll Faust, Tulane University; secretary, Clay G. Huff, Naval Medical Research Institute, Bethesda, Maryland; treasurer, Henry E. Meleney, New York University; and councillor, Willard H. Wright, National Institutes of Health, Bethesda, Maryland. At the same meeting workers in the fields of parasitology and tropical medicine of the midwest were organized as **Midwestern Parasitologists** and elected H. J. Van Cleave, of the University of Illinois, as president. Plans are under way for a meeting of the group at the University of Wisconsin in June. Information about the meeting and membership may be had by writing David R. Lincicome, Department of Microbiology, University of Wisconsin Medical School, Madison.

The recently organized American College of Veterinary Pathology elected the following temporary officers to serve until the final adoption of its constitution and by-laws: president, William H. Feldman; vice president, Alfred G. Karlson; secretary-treasurer, T. C. Jones.

The Cooper Union Forum is conducting three series of lectures on Sundays, Tuesdays and Fridays, at 8:15 in the Great Hall, 8th Street and Astor Place, New York City. The subject of the Sunday evening series (January 23–April 10) is "Asia in Ferment." The Tuesday evening series (January 25–April 12) is concerned with "Our Search for Mental Health." The Friday series (January 28–April 8) offers "Expressions of the Contemporary Scene."

The Institute of Medicine of Chicago, at its annual meeting on December 7, elected the following officers for 1949: Henry T. Ricketts, chairman of the Board of Governors; William F. Petersen, vice chairman; Herman L. Kretschmer, president; Archibald L. Hoyne, vice president; George H. Coleman, secretary; and Grant H. Laing, treasurer. Warren W. Furey, Eric Oldberg, Charles B. Puestow and H. Prather Saunders were elected to the Board of Governors. An illuminated parchment scroll was presented to George H. Coleman as a tribute of appreciation for 25 years of service as secretary. Citizen fellowship was conferred on Ella M. Salmonsen, medical librarian of the John Crerar Library.

NRC News

The Pacific Science Board, with the cooperation of the Navy Department, and assisted by funds from the Office of Naval Research, the Viking Fund, Inc., and private sources, is conducting a program known as Scientific Investigations in Micronesia. The program, which is a continuation of Coordinated Investigation of Micronesian Anthropology, carried on in the Trust Territory of the Pacific Islands for the past two years, offers 10 research openings with the following probable distribution: 2 anthropologists (archeology, physical anthropology, or linguistics); 2 botanists; 1 geographer (human or economic); 1 medical researcher (hypertension or parasitology); 1 nutrition researcher; 3 zoologists (1 in entomology). The estimated time in the field for these assignments will be not less than 4 or 5 months, with individual salary supplements ranging from $100 to $400 per month, depending upon the qualifications of the applicant. In addition, there will be a reimbursement for field expenses including subsistence and native assistance up to $100 per month. Transportation outside the continental U. S. will be arranged by the Navy Department. While unattached scientists may be sent out on individual contracts, the Board favors the former arrangement of the CIMA program, under which participants were sponsored by an institution assisting them with equipment, publication of results, and supplementary funds.

Applications for the research openings should be sent to the Pacific Science Office, NRC, 2101 Constitution Avenue, Washington 25, D. C., so as to arrive before *April 1*. It is expected that assignments and field arrangements can be made effective by early June. All applications should be on a graduate or on a post-doctoral level, and should contain details of previous field experience and academic background, as well as a description of the proposed research project, including the locality considered most desirable.

The Committee for Research in Problems of Sex of the National Research Council announces that requests for grants-in-aid during the fiscal period July 1, 1949–June 30, 1950, will be received until *March 15*. Application blanks may be obtained from the Division of Medical Sciences, National Research Council, 2101 Constitution Avenue, Washington 25, D. C. Preliminary inquiries should be addressed to the chairman of the committee, George W. Corner, director of the Department of Embryology, Carnegie Institution of Washington, Wolfe and Madison Streets, Baltimore 5, Maryland.

Members of the Committee on Aviation Psychology were recent guests of the Secretary of the Navy aboard the aircraft carrier Saipan, on a cruise to Guantanamo Bay, Cuba. The group also included Navy doctors and psychologists of the Bureau of Medicine and Surgery. En route, a regular meeting of the Committee was held to discuss the Navy's current research program in aviation psychology and to review the progress made on investigations conducted for the Bureau of Medicine and Surgery by the Committee.

H. R. Crookshank, formerly in the Biochemistry Department of the Medical College of Alabama, is now assistant executive secretary of the Division of Biology and Agriculture and the American Institute of Biological Sciences of the NRC.

Deaths

Imre, F. Patai, 54, physicist and a member of the staff of Franklin Insitute's Bartol Research Foundation at Swarthmore, Pennsylvania, died January 19 in the University of Pennsylvania Hospital after a brief illness.

Stephen Capps, 67, U. S. Geological Survey geologist, died January 19 in Washington, D. C. of a heart attack.

William Clarence Ebaugh, 71, professor emeritus of chemistry at Denison University, Granville, Ohio, died in Newark, Ohio, December 28.

The American Academy of Arts and Sciences, 28 Newbury Street, Boston, is presenting an exhibit and a series of popular lectures on astronomy during February. Prepared by the staff at the Harvard College Observatory and sponsored by the Academy, the program includes daily lectures on astronomical subjects as well as exhibits of current activities at the Harvard observing stations and transparency panels on the galaxies, the Milky Way, the sun, and meteors. The exhibit is open from 9 a.m. to 5 p.m. on weekdays and 9 a.m. to 12 noon on Saturdays. The lectures are given at 3:45 during the week and at 11:00 a.m. on Saturdays. They are open to the public without charge.

UNESCO will provide a weekly radio news program on developments in the fields of education, science, and culture, to be available to U. S. radio stations beginning February 19. The scripts will be prepared by the Paris headquarters of UNESCO and transmitted to broadcasting networks throughout the world. Radio stations in the United States may request copies of the programs, which are entitled "UNESCO World Review—Weekly Radio News About Education, Science, and Culture," from the UNESCO Relations Staff, Department of State, 1778 Pennsylvania Avenue, Washington 25, D. C.

The Avawatz Mountains, 40 miles south of Death Valley, are being mapped by Richard H. Jahns, geologist, and A. E. J. Engel, mineralogist, of the California Institute of Technology. Object of the survey is to trace the Garlock Fault, (which appears from aerial photographs to lie along the east side of the range) and determine whether this area contains the key to important regional geological structures in the Southwest. The fault has been active for millions of years. By mapping the inner recesses of the range, which has a maximum altitude of about 6,000 feet, Drs. Jahns and Engel hope to learn how far the mountains have moved and when the moving took place.

The American Psychiatric Association's newly established Inspection and Rating System for mental hospitals in the U. S. and Canada will have as director Ralph M. Chambers, until recently superintendent of Taunton State Hospital, Taunton, Massachusetts. A Central Inspection Board of 10 psychiatrists under the chairmanship of M. A. Tarumianz, superintendent of Delaware State Hospital, Farnhurst, Delaware, will serve as the governing body of the new system. Made possible by grants from the Psychiatric Foundation, the Inspection and Rating System is designed to stimulate the same kind of voluntary improvement in public and private mental hospitals that a similar procedure developed in 1918 by the American College of Surgeons achieved in general hospitals. Communications concerning the Inspection and Rating System should be directed to Ralph M. Chambers, c/o American Psychiatric Association, 1270 Avenue of the Americas, New York City.

A method of studying wind velocities in the upper atmosphere by means of visible smoke clouds has been made possible by the V-2 rocket No. 42, fired at White Sands, New Mexico, last December. The rocket reached an altitude of about 67 miles at a speed of 3,000 mph. The smoke generator was equipped with a delay mechanism timed to function 68 sec after take-off and when the rocket rose from 20 to 40 miles, it emitted a stream of smoke clearly visible for 15 minutes. The movement of the smoke in the wind was photographed by cameras on the ground, thus measuring velocity at a height from 100,000 to 200,000 feet above the earth's surface. The equipment was designed and operated by experts from the Munitions Division, Technical Command, Army Chemical Center, Maryland.

"The Behavior of Rocks and Rock Masses in Relation to Military Geology" is the subject of volume 44, number 1, of the Colorado School of Mines *Quarterly*, now available for distribution. The author is Wilmot R. McCutchen, Lt. Col., Corps of Engineers, USA. The report may be obtained from the department of publications, Colorado School of Mines, Golden, Colorado, for $1.00 postpaid in the United States.

The Foreign Service Institute of the Department of State is instructing Foreign Service Officers and other government personnel in those phases of sociological and anthropological science appropriate to the conduct of relations with peoples of other cultures. This "area and language study" is carried out by the following staff: Henry Lee Smith, Jr., director of the School of Language Training and assistant director of the Institute; George L. Trager, professor of linguistics and anthropology; John M. Echols, associate professor of linguistics; Charles A. Ferguson and Carleton T. Hodge, assistant professors of linguistics, Naomi Pekmezian, instructor in linguistics, and Edward A. Kennard, professor of anthropology and linguistics (School of Advanced Officer Training).

Recently Received—

Report of the Chief of the Soil Conservation Service, 1948, by H. H. Bennett. Publication of the U. S. Department of Agriculture. Washington 25, D. C.: Supt. of Documents, U. S. Government Printing Office, 1948. $.20.

Soviet science (from *Pravda*). (Occasional pamphlet no. 8, November, 1948, of the Society for Freedom in Science.) Copies available from the Assistant Secretary, Society for Freedom in Science, Dept. of Zoology, University Museum, Oxford, England.

The subspecies of the Massasauga, *Sistrurus catenatus*, in Missouri by Philip D. Evans and Howard K. Gloyd. (Bulletin of the Chicago Academy of Sciences, December 22, 1948.)

Ninetieth anniversary celebration of the Iowa State College, 1858–1948. Iowa State College, Ames, Iowa.

Bulletin Analytique, Vol. VII, Parts 1 and 2. Published monthly by Le Centre National de la Recherche Scientifique, Service de Documentation du C.N.R.S., 18, rue Pierre-Curie, Paris (5^e).

Science Review. Official monthly publication of the Metropolitan Detroit Science Club.

National Research News. Published monthly by the National Research Council of Canada.

Symposium on spectroscopic light sources. (Special technical publication No. 76.) Published by the American Society for Testing Materials, 1916 Race Street, Philadelphia 3.

Australian Journal of Scientific Research. Published by the Council for Scientific and Industrial Research in collaboration with the Australian National Research Council. Issued in two series. Annual subscription each series. 30/, single issues 7/6. Ed: Australian Journal of Scientific Research, c/o Council for Scientific and Industrial Research, 314 Albert Street, East Melbourne, C.2., Victoria.

Preliminary bulletin of postgraduate courses. American College of Physicians, Inc., Spring, 1949, Executive Secretary, E. R. Loveland, 4200 Pine Street, Philadelphia.

Dania Polyglotta. Annual report published by the Institut Danois de Échanges Internationaux de Publications Scientifiques et Littéraires I.D.E., Copenhagen, Denmark.

Report of the President of the Carnegie Institution of Washington for the year ending September 30, 1948.

Wissenschaftliche Dienst. Published monthly by Internationale Presse Austausch Gesellschaft M.B.H., Hamburg 13, Harvestehuder Weg 5, Germany.

New Products. Booklet published by The N. Y. Journal of Commerce., 63 Park Row, New York City. $.50.

Make Plans for—

Research Conference on Coccidiosis of the New York Academy of Sciences, March 4–5 (originally scheduled for March 3–4), American Museum of Natural History, New York City.

New York Academy of Medicine, Section of Microbiology, symposium, March 15–16, New York City.

American College of Physicians, 30th annual session, March 28–April 1, New York City.

Rhythmic Behavior of the Nervous System

Hudson Hoagland, *Executive Director,*
Worcester Foundation for Experimental Biology, Shrewsbury, Massachusetts

SINCE THE FAMOUS CONTROVERSY of Galvani and Volta in the last decade of the 18th Century, it has been known that living tissues generate electricity, and in 1848, when this Association was founded, many studies of the electrical properties of nerve and muscle had already been published. By that year, du Bois Reymond had, for example, published a two-volume study of animal electricity, and in 1850 Helmholz measured the rate of propagation of the nerve message for the first time and found it to be absurdly low for conducted electrical action—of the order of 20 meters per second in frog nerve.

It is now established that all living cells are continuous converters of energy, and the form and function of the cell are maintained by dynamic steady states. Only dead cells are in thermodynamic equilibrium with their environments. Within each cell, linked enzyme systems promote in stepwise sequences the degradation of foodstuffs that have entered the cell from its environment of body fluids, of sea water, or of fresh pond water, depending on its habitat.

Membranes separating the protoplasmic contents from the environment are selectively permeable. Due to the asymmetric steady-state flow of substances, including electrolytes, across cell walls, these walls are polarized so that, in most cells, the interior is found to be from 50 to 100 millivolts negative to the exterior. Cells store potential chemical energy, and because they are irritable, this energy can be converted suddenly to other forms. Thus a local decrease in the permeability of a cell membrane, initiated by electrical, chemical, mechanical, or thermal means, permits the cells' own currents to flow through this region of changed permeability from the positively charged outside to the more negatively charged inside and to complete the circuit by flowing back out more diffusely through the adjacent intact membrane. Such a local current in itself may act as an electrical stimulus to release energy from adjacent areas of the cell, so that a wave of electrochemical change is propagated away from the stimulated region as swirling eddies of inwardly and outwardly directed current. In long filamentous cells, such as nerve fibers, the passage of such impulses is detectable with recording apparatus.

Waves of Action in Nerve Tissue

Any study of the behavior of nerve mechanisms becomes a study of waves and rhythms. The impulses in afferent nerve fibers that convey information to the brain and the signals sent out by the brain over motor nerve fibers to muscles are waves of electrochemical change that sweep along the fibers at speeds ranging from a fraction of a meter per second in very small fibers to 120 meters per second in large fibers. Accompanying the passage of impulses in nerve are definite electrical, chemical, and thermal changes.

During the first two decades of this century, primarily through the work of Gotch and of Lucas, it was learned that nerve impulses travel as discrete pulses of energy, and following each pulse or wave, the nerve is refractory to further stimulation for very brief intervals of the order of milliseconds or fractions thereof. Time is required for membrane excitability to be restored by metabolism.

The accelerating development of good electronic devices by physicists and engineers since the middle 1920's has yielded much information about impulses in individual sensory and motor nerve fibers and the ways in which sensory nerves transmit information from the environment to the brain. Adrian and a number of other physiologists have shown that intensity of sensation and strength of muscular contraction are correlated with frequency of nerve impulses, but quality or modality of sensation is not traceable to peripheral nerve impulses but is rather a central phenomenon of the brain.

Impulse conduction across junctions between nerve cells, called synapses, takes place in only one direction. While nonsynaptic nerve nets exist in lower animal forms, such as coelenterates, well-integrated and complex behavior requires effective switching devices as represented by the one-way synapse, where temporal and spatial summation of impulses takes place, permitting control and direction of excitation and inhibition of contiguous cell units.

The nature of waves of action in nerve tissue was well described by A. V. Hill (7) in 1933, when he wrote:

> "Most of the well-known oscillations with which physics is concerned are a consequence of the reaction with one another of properties analogous to inertia and elasticity. A moving or a changing system tends, on the one hand, to continue in its state of motion because it possesses, for example, mass or inductance; even social, economic and intellectual changes are endowed with such characters of inertia which keep them going when they have passed a true position of equilibrium. On the other hand, such

systems, if they are to continue to exist, if they are not merely to be dissipated, must possess converse properties which tend to bring them back once they have overshot their equilibrium: such properties in physics are elasticity and electrical capacity; in finance and politics, fear and conservatism. These exercise a constraining force increasing with the displacement from equilibrium, and ultimately reverse the motion or change and the same oscillation is repeated in the opposite direction.

''There is, however, another type of oscillation, less commonly discussed in physics and mechanics but nonetheless well-known in everyday affairs; that which depends upon a discharge taking place when some limiting potential or intensity is reached. For example, water falling into a tank equipped with a syphon will come out in rushes whenever it rises to a certain level. Or again, a population in which an epidemic of measles cannot start because of the number of people in it who are immune, having had the disease already, will gradually become less immune as time goes on, and finally an epidemic, a wave of measles, will sweep through it. A neon lamp with a parallel condenser in series with a resistance and an electromotive force, will discharge at regular intervals, namely whenever the potential difference across the condenser reaches a certain critical value. This type of oscillation does not depend upon inertia reacting with elasticity. Its essential nature is that (a) some state, some potential, some intensity, is built up by a continuous process, and the condition becomes less and less stable until one is reached in which discharge must take place, and (b) this discharge, once started, forms a path for itself by which (as in a syphon or an electric arc) further discharge is facilitated until what has been built up gradually has been broken down and the process begins again. This type of oscillator (sometimes referred to as a relaxation oscillator) is the one with which we are concerned in physiology.

''Waves may be transmitted on the same principle in a system extended in space. An unstable state is gradually built up at some point, either through an external agency or by some intrinsic process, discharge is begun which starts and facilitates a discharge in neighboring regions which themselves discharge, and so a wave is propagated. Such waves will occur periodically if at some region the potential at which discharge begins is less than that finally attained by the continuous process of charging. They will require, however, an external agency (a 'stimulus') to start them if the unstable condition, the limiting potential, is not attained spontaneously. Models of such waves will occur to all of you; their principle is obvious. I have emphasized it because the waves on which nervous activity is based appear to be of this type. All detailed theories of nervous transmission may well be wrong but this general idea of it, involving a building up and discharge, is almost certainly right.''

All human behavior, whether it be a reflex response to stepping on a tack or the development of a mathematical analysis, depends finally on the organization of messages in the central nervous system. As Johannes Müller stated over a century ago, we do not sense a direct external world but rather properties of this world as interpreted by our nervous system. Since all nerve messages in individual nerve fibers are alike except for differences in timing and voltage, this means that patterns of organization of messages in the brain must be the ultimate basis for the rich quality of our experience, including ideas themselves.

ELECTRICAL BRAIN WAVES

In 1929, Hans Berger reported sinusoidal electrical oscillations of a frequency of about 10 per second picked up from electrodes attached to the scalp of relaxed human subjects with closed eyes. Berger's important observations were soon confirmed and in the past 18 years hundreds of studies of electrical activity of the brain, animal and human, have appeared.

The electroencephalogram, or EEG, as the brain wave record is called, usually displays a dominant frequency called the alpha rhythm of 9 to 11 cycles per second at an amplitude of 20 to 50 microvolts, most conspicuous from the occipital region of the head over the region of the brain concerned with visual processes, although it is often manifest all over the head. Exploration of nuclei and tracts in exposed brains of living animals and of man at operation show that all of the brain centers are rhythmically active at frequencies of 2 to 30 cycles per second with different frequencies characteristic of different nuclei but with predominant activity in the range of 8 to 18 cycles per second. Fig. 1, for example, shows cortical and hypothalamic records taken by us from an unanesthetized and contented dog with small electrodes permanently imbedded in the cortex and in the hypothalamus. The cortical records and the ones from the anterior hypothalamus show the same type of waves, although the activity from the posterior hypothalamus displays faster and more irregular fre-

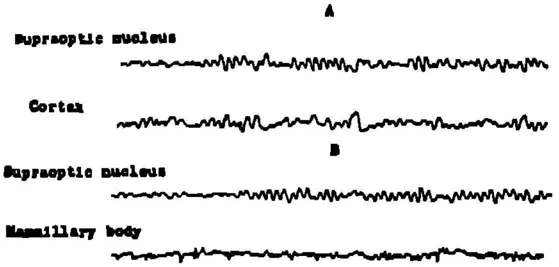

FIG. 1. Two pairs of records from an unanesthetized dog with small leads inserted in the brain. A—Upper from anterior hypothalamus; lower from cortex (simultaneous recording). The dominant rhythms are 14 per sec. B—Upper from anterior hypothalamus; lower from mammillary body (simultaneous recording). From Hoagland, Himwich, Campbell, Fazekas, and Hadidian, *J. Neurophysiol.* 1939, 2, 276.

quencies. Fig. 2 shows pairs of EEG tracings from each of 5 persons. The upper trace of each pair is from the occipital cortex and the lower trace is from a lead at the roof of the pharynx near the anterior hypothalamus. Somewhat different brain wave patterns characterize each individual, but it is interesting [illegible] imilarity of the records from two such remote brain areas in the same person.

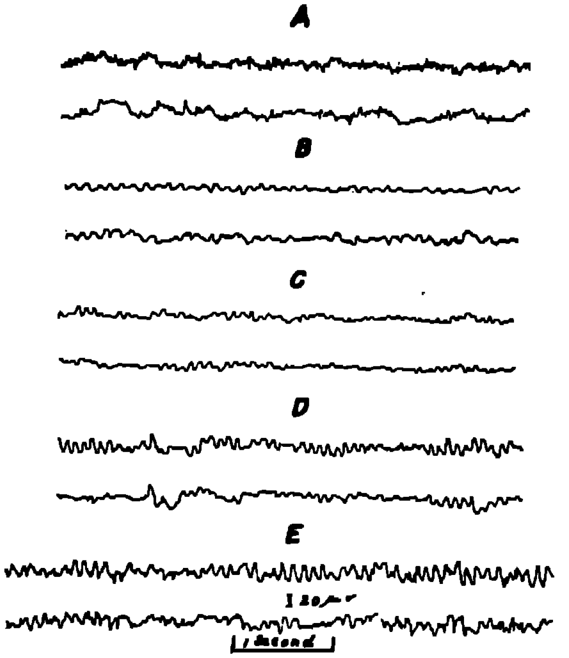

Fig. 2. Pairs of electroencephalographic tracings from five persons. A, B, C, D, and E refer to different individuals. The upper tracing of each pair is from a cortical electroencephalogram, and the lower tracing of each pair is from a recording made simultaneously with a lead inserted in the roof of the pharynx near the anterior hypothalamus. The upper tracings of A, B, and D are from the vertex. The upper tracings of C and E are from the occiput. Note similarities of patterns in a given individual from cortical and basal leads. From Hoagland, Cameron, Rubin, and Tegelberg, *J. gen. Psychol.*, 1938, **19**, 247.

While the EEG is generally characterized by a dominant frequency of around 10 cycles per second, Fourier transforms make it clear that a whole spectrum of waves ranging from 2 to 30 cycles per second is present from any given locus. There is considerable variation in the dominance of components of the frequencies from person to person and studies of identical twins and of family groups in general show a strong tendency for the particular EEG patterns to be inherited. This is also true of abnormal patterns that have proved useful in diagnosing epilepsies.

The brain waves are composed of electrical discharges of many cells firing in synchrony and the sinusoidal pattern appears to be due to the distribution of thresholds of firing of groups of cells. Evidence indicates that reverberating circuits of activity, involving one-way cell-to-cell synaptic conduction between thalamus and cortex and back again, and even between hypothalamus, thalamus and cortex, are involved in the rhythms, since suitably placed lesions in these lower centers may abolish some of the cortical rhythms, apparently by interrupting loops of neurone-to-neurone conduction. But, on the other hand, conduction can take place from cell to cell in oriented polarized brain cell layers by electrotonic action from active to inactive cells by way of electrical conduction through bathing fluids and independent of synaptic circuits. This phenomenon has been demonstrated by studies from the laboratory of F. Bremer (*2*, *3*) of Brussels and in this country by Gerard et al. (*5*) in studies of electrical waves in frog brain and in isolated pieces of frog brain. Moreover, in lobotomy operations, cutting connections of the frontal lobe of the cortex with the thalamus in man does not modify the frontal brain wave patterns. Thus, both synaptic conduction and nonsynaptic electrotonic conduction appear to be involved in the spread of brain waves in

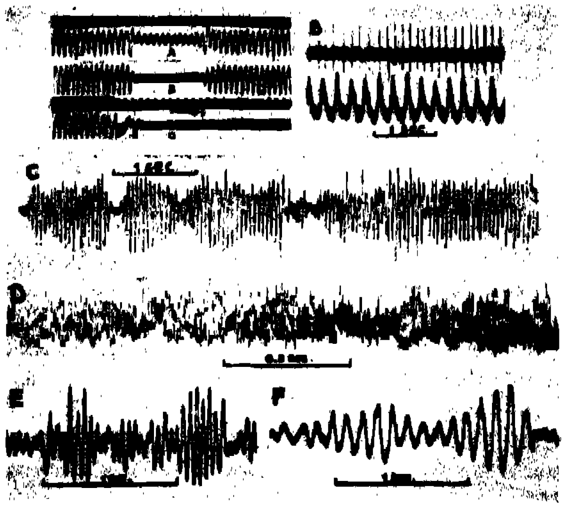

Fig. 3. Waves and rhythms from different central nervous systems as figured by F. Bremer (*J. belge Neurol. Psychiat.*, 1947, **47**, 542). A—Optic ganglion of the beetle *Dytiscus*: effect of light of increasing intensity (A through C) in abolishing the rhythm (from Adrian, 1937). B—Catenary ganglion of the lobster: ganglionic waves (below) and nerve impulses led from an interconnecting nerve trunk (from Bonnet, 1938). C—Gray substance of the anterior horn of the cat spinal cord discharging synchronously after a period of asphyxia (from Bremer, 1941). D—Cat cerebellar cortex: synchronous activity following brief electrical stimulation (from Dow, 1937). E and F—Rhythmic activity in two functional states of the cerebral cortex of the cat after surgical de-afferentiation (from Bremer).

central nerve tissue, and work of a number of investigators has shown basic brain wave rhythms to be independent of the arrival of afferent impulses, although such impulses can modify the rhythms. Fig. 3, from a paper of Bremer (*2*), illustrates brain wave rhythms of central nervous tissue from beetles to mammals.

A variety of factors have been found to change the EEG patterns. Thus, the alpha rhythm is characteristic of the subject at rest with eyes closed. Pattern vision with the eyes opened, i.e., focusing visual attention, and even the recall of visual images with the eyes closed, abolishes it although it is not abolished even by strong diffuse illumination through closed lids. Occupation of the visual cortex with pattern discrimination disrupts the synchronized neurone beats.

Sleep and even drowsiness, together with a variety of conditions of impaired consciousness produced by drugs, are accompanied by slowing and disruption of the dominant alpha frequency and its replacement by more or less slow random waves.

One factor determining the basic frequency of the dominant rhythms, other things being equal, seems to be the rate at which the brain burns sugar, its only normal fuel. Thus, there is a progressive slowing of alpha frequency with decreasing sugar or oxygen carried by the blood to the brain or by the administration of inhibitors of the brain's oxidative enzyme systems; conversely, metabolic stimulants increase the frequency. Increasing the alkalinity of the blood slows the frequencies, an effect which is easily demonstrable by rapid deep breathing that blows off carbon dioxide.

Increasing the internal body temperature by fever or by diathermy increases alpha brain wave frequencies and some years ago we found that the Arrhenius equation relating the rates of pace-limiting simple chemical processes to temperature describes this relationship, and gives three values for the activation energy. Two of those values are identified with specific enzyme systems which are known to be present in the brain and which appear to act in the brain's sequence of oxidation steps as rate-limiting chemical pacemakers for the alpha frequencies (*6, 8*).

These metabolic findings are consistent with the view expressed by Hill in our earlier quotation; namely, that nerve cells function as relaxation oscillators that may fire repetitively in response to voltages built up across the cell's membranes by cellular oxidation. This general point of view applies equally well whether the cells are regarded as firing as independent units stimulating neighboring cells to synchrony by electrotonic action or whether the brain waves are due to synchronized reverberating circuits involving, by synaptic conduction, extensive brain regions in loops of activity.

It is of interest in this connection that we have found the human time sense to obey the Arrhenius equation and yield an activation energy similar to that encountered in some studies of cell respiration but different from that for alpha frequencies. The subjective counting of the number of seconds in a minute speeds up with elevated internal body temperature so that more seconds seem to pass per minute and private time therefore appears to drag in comparison with public time accepted as a standard. Our sense of time itself thus seems to be regulated by some as yet unidentified enzyme system, a sort of master chemical clock with an activation energy of 24,000 calories. Fig. 4 demonstrates these data.

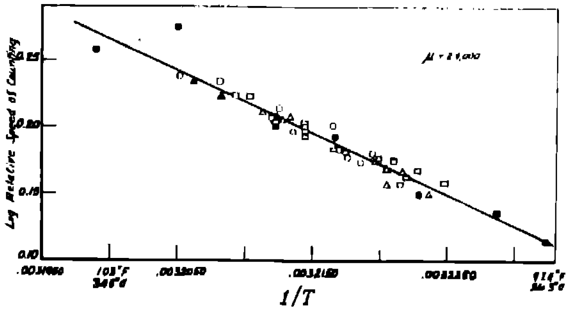

Fig. 4. Arrhenius equation plot showing effect of internal temperature on the rate of estimating time. Different symbols refer to different persons. The absolute rate of counting is not indicated, since the ordinate has been telescoped. From Hoagland, *J. gen. Psychol.*, 1933, **9**, 260.

On the clinical side, during the past 15 years electroencephalography has proved to be an important adjunct in diagnosis of epilepsy and in localizing brain lesions for subsequent surgery.

Brain Physiology and Behavior

The discovery of continuous rhythmical electrical activity in the brain has opened new possibilities of interpreting the physiological basis of behavior. Mental processes have a continuity, and consciousness is an enduring affair interrupted at intervals by the sleep rhythm but otherwise normally persisting throughout life. Nothing in the study of classical reflex mechanisms has adequately accounted for learning and the persistence of memory. For a century after Magendie and Bell, the brain was regarded as a complex system of pathways whereby impulses from the periphery reached effector organs to produce behavior in stimulus-response sequences and, while many excellent studies of spinal reflexes shed light on the physiology of these fundamental units of behavior, little progress in correlating brain physiology with higher mental processes was possible so long as the brain was regarded merely as a classical passive telephone-switchboard. Who, after all, plugged in the right connections? Who or what was the operator of this inert switching system? Obviously the brain itself—but how?

Since 1943 several contributions have appeared which shed suggestive light on this problem. Thus, Rosenblueth, Wiener, and Bigelow (*11*); Pitts and McCulloch (*10*); Adrian (*1*); and more recently Northrop (*9*) have considered these matters from refreshingly new angles. It has been my privilege to read in manuscript Norbert Wiener's book *Cybernetics, or control and communication in the animal and the machine* (*13*) and I should now like briefly to consider a few of the matters pertinent to waves and rhythms raised in these studies.

In 1940 Wiener worked out the principles of a machine now in operation for the solution of partial differential equations with more than one variable, and has made interesting comparisons of this machine with the brain. Kenneth Craik in his book *The nature of explanation* (*4*) has made similar comparisons but Wiener's analysis is more extensive. The machine is fed data and proceeds to perform a complicated series of logical operations at a rapid rate through electronic switching devices. The computations are based on a scale of two after the algorithms of Boolian algebra rather than on a scale of ten, and electronic relays which give an on-off or a yes-no answer are the switching devices employed.

All data according to the rules of logic and number are operated upon by the machine in sets of choices between two alternatives, and all the operations on the data take the form of making a set of new choices dependent on a set of earlier choices. The operations are timed by a central clocking device. This clocking may be performed by an actual clock, or its equivalent may be performed by not permitting a process to take place until its antecedents have occurred.

No human interference with the processes takes place from the time of supplying the machine with its initial information until the end of the calculations. Thousands of ordered operations take place at an exceedingly rapid rate, condensing into minutes processes that would require days to complete with ordinary methods of computation.

In such a machine there are devices to retain impulses until it is time for the appropriate circuit to act and relate them to other events in the processes of computation. This may be done in the machine by systems of reverberating circuits and by electronic scanning devices, such as are used in television and also in the form of magnetization patterns of the molecules in iron wire after the manner of the well-known wire recorder. Thus, information can be stored until ready for use, and the machine quite literally possesses a functional memory in the form of patterns of dynamic electrical configurations or of molecular patterns which may be called upon to furnish information by appropriate stimuli arriving as timed pulses from other circuits in the apparatus. It is important to realize that this memory need not be lodged in any one locus in the machine, but belongs to its function as a whole. To ignore this is to commit the fallacy of Descartes in locating the action of mind on matter in the pineal gland.

A basic controlling principle in the integration of patterns of activity in the machine is that of negative feed-back, and evidence clearly indicates that negative feed-back plays a fundamental role in nervous integration. In any system displaying negative feed-back, some of the output of the system returns to limit and control its further output. Thus, Rosenblueth, Wiener, and Bigelow point out that negative feed-back means the behavior of an object is controlled by the margin of error at which the object stands at a given time with reference to a relatively specific goal. A robot-controlled plane may, for example, be directed automatically to seek its target by electromagnetic waves sent out by it and reflected back from the target so as to modify the steering mechanism. The proximity fuse detonates the shell as it approaches the target by the return of electromagnetic waves broadcast from the shell and reflected back to it. Again, the thermostatically controlled house heating system is a more prosaic example of negative feed-back, since as the temperature rises it shuts off the heater and when the house cools off the furnace is turned on again by the thermostat. Engine governors and the steering engines of ships furnish other examples of negative feed-back, and mechanisms so controlled are called servomechanisms.

Nervous system processes are replete with examples of negative feed-back. Thus increasing blood pressure excites stretch receptors in the carotid sinus, which sends to the vasomotor center impulses causing a fall in blood pressure. Homeostatic mechanisms in general that regulate our internal environment use principles of negative feed-back. Breathing movements are examples of control of rhythms of inspiration and expiration by negative feed-back. Another example is the control of movements of the limbs by reciprocal inhibition of antagonistic muscles, producing orderly movement, and Adrian in his *Physical background of perception* (*1*) has discussed a number of such mechanisms familiar to neurophysiologists. The cerebellum is a complex coordinating center for smoothly controlling by way of negative feed-back sensory impulses from the limbs essential to precisely coordinated movements.

Lorente de Nó has demonstrated the action of what he calls reverberating chains of neurones so arranged in closed paths in the central nervous system that each neurone excites the next around the loop, the last finally reexciting the first. With 10 billion neurones in the human central nervous system an appalling number of interacting neurone loops are possible. Action once started in such reverberating circuits can continue indefinitely as long as metabolism supplies the requisite energy.

Suppose now that one or more of the neurones in such a loop is fired by a specific sensory impulse. This loop involving many neurones will correspond to the physiological substratum of that specific sensory event and as McCulloch has put it "A train of impulses in a regenerative loop preserves the form of the fact without reference to the one particular moment when it was experienced." Comparable loops of activity are stored in the electronic calculating machine by use of reverberating systems and principles of electronic scanning.

Wiener also points out that the neurone operates on an on-off basis like an electronic relay. It either fires or not, and the parallel to the machine and its binary scale of operation is thus further borne out in terms of the basic units comprising the brain and the machine. Changing the grid bias of tubes by automatic devices modifies the tube's timing and in like manner negative and positive after-potentials of neurones are important in regulating impulse passage at synapses through modifications of synaptic excitability.

Voluntary acts by their very nature exemplify negative feed-back. Thus when we proceed to pick up an object from a table we do not command a specific sequence of muscular acts. Rather, as Wiener suggests, the controlling factor in the act is the degree to which the act has not been completed. The object may be picked up with either the right or left hand or even by the mouth if the hands are tied. The action ceases when the purpose is realized, after the manner in which servomechanisms control actions and bring them to a stop. Servomechanisms are purposive in nature.

Rosenblueth and Wiener are preparing for publication an experimental study of muscle clonus in spinal and in decerebrate cats. From an anlysis of the clonus frequency based on the theory of servomechanisms, they found good preliminary agreement between calculated and experimental values of the muscle's rhythm of contraction in response to stimulation of its myotatic receptors by stretch.

FORM PERCEPTION AND MEMORY

Pitts and McCulloch (*10*) published a paper entitled: "How we know universals, the perception of auditory and visual forms." In this paper they present both anatomical diagrams based on cortical neuroanatomy and a mathematical analysis indicating how a scanning mechanism consisting of waves of impulses sweeping up and down over interlacing nonspecific and associative afferent fibers in the cortex can furnish a basis for the perception and recognition of form when specific afferent stimuli arrive over sensory pathways. In this type of nerve network, form, whether that of a musical chord or a geometrical pattern, is independent of size or position in the field and it is independent of any particular neurone or small neurone group. In this connection it is interesting to recall that Lashley found recognition of patterns and retention of learned acts in rats to be affected to a surprisingly small degree by the surgical removal of specific anatomical brain areas. Retention of learned acts seemed to depend more upon the amount of tissue left than on its locus.

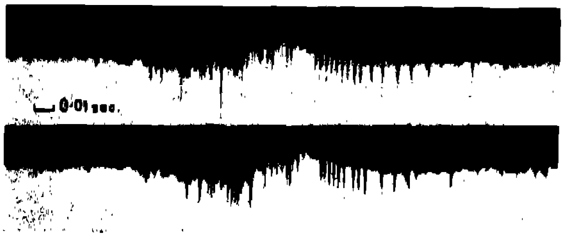

Fig. 5. Complex discharges in several units of the cerebral cortex following the local application of strychnine. Both outbursts are due to sensory stimulation (touching the foot) and show the tendency for the cortex to repeat the same pattern of discharge. From Adrian and Moruzzi, *J. Physiol.*, 1939, 97, 153.

Pitts and McCulloch write "It is to the nonspecific afferents that modern physiology attributes the well-known rhythmic sweep of a sheet of negativity up and down through the cortex—the alpha rhythm. If our model fits the facts this alpha rhythm performs a temporal 'scanning' of the cortex which thereby gains, at the cost of time, the equivalent of another spatial dimension."

Lashley's experiments with rats indicate that memory traces occupy very extensive cortical areas, since the ablation or transection of a given region does not destroy memory, and he has suggested that signals reaching receiving areas of the cortex may reverberate extensively, affecting patterns of action in innumerable rhythmically acting local circuits. Memory traces would then be more or less stable resonance patterns which might be extensively reduplicated all over the cortex, ready to respond to incoming signals which fitted the pattern of response. Fig. 5, from a paper of Adrian and Moruzzi, shows such a pattern at one point on the cortex set up in response to a specific sensory stimulation of the foot.

But, as Adrian (*1*) has pointed out, it is difficult to see how memories can survive great changes in the over-all patterns of activity of the brain such as occur in normal sleep or in anaesthesia. As Adrian has stated in his lectures on the "Physical Background of Perception," "Clearly if memory traces are patterns they must tend to occur in the same form after a period of inactivity and to bring this about it seems to be necessary to postulate some semipermanent modification as well. A slight change in the exceedingly plastic structure of nerve cells and dendrites would be enough [following activity]." In this connection I would like to suggest by analogy that the storage of information in the wire recorder modifies the wire at a molecular level but not within optically observable microscopic dimensions and information fed by such a wire to scanning circuits can reappear in its original form after a shutdown of the apparatus when its circuits are later reactivated.

Finally, it is worth recalling that both the brain and the machine operate in relation to internal master clocks. In the case of the brain, steady-state enzyme kinetics appear to regulate our time sense.

PHILOSOPHICAL IMPLICATIONS

Northrop, in a paper entitled "The Neurological and Behavioristic Psychological Basis of the Ordering of Society by Means of Ideas" (*9*), has discussed the work of Wiener, Rosenblueth, McCulloch and Pitts against the background of two opposing philosophical views of the role of ideas as determinants of behavior. To the Lockian and Cartesian dualists and to the idealistic German philosophers there are only mechanical causes and no purposes or universals in the biological realm, only particular events and no remembered events with their persistent meanings. According to these classical views, purpose, memory, and the existence of universals establish the reality of nonbiological minds or mental substances and thus lead to the formulation of vitalistic theories. Opposing these views have been the mechanistic biologists and the behavioristic psychologists for whom purpose and mind are mere appearances or epiphenomena, and only stimuli and observed responses are real. Ideas as determinative causes are regarded as mere rationalizations after the fact of behavior.

Northrop dismisses both of these points of view in terms of the light shed by the recent neurophysiological concepts, pointing out that purposeful goal-directed behavior is possible in human neurological systems containing negative feed-back mechanisms and patterns of reverberating circuits which are the epistemic correlates of ideas and which can function causally. Signals from the goal can alter behavior after it has been initiated so that it reaches the goal. This is the requirement for any mechanism in order that it be goal-directed and "a teleological system can be—and in the human nervous system it is—a mechanical system. It is a mechanical system in which the behavior of the system is controlled by a negative feed-back over the goal.

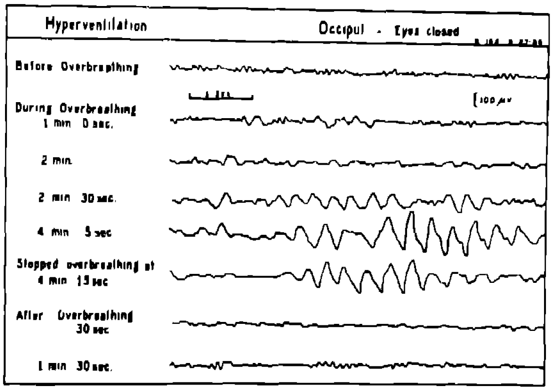

Fig. 6. Effects of hyperventilation on the human electroencephalogram. Note marked slowing accompanying the excessive removal of CO_2 by overbreathing. From Davis and Davis, Res. Publ. Ass. nerv. ment. Dis., 1939, **19**, 50.

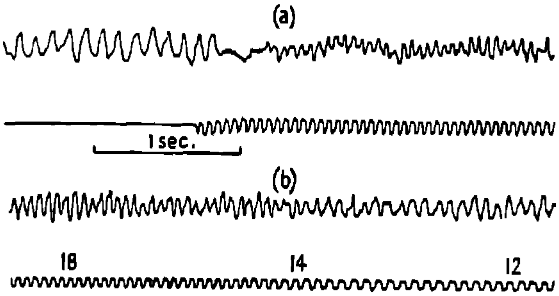

Fig. 7. Records from the occipital region of the head, showing the effect of flickering light. Below the records from the head are tracings from a photoelectric cell indicating the rate of flicker. In the lower record the rate was reduced from 18 to 12 per sec, and the cerebral waves keep in step with the flicker. The cerebral waves are potential changes of the order of 20–30 microvolts. Adrian reports that the alpha frequency here driven at 18 per sec can be driven up to 30 per sec by flickering light. From Adrian, *Lancet*, 10 July, 1943, p. 34.

"Because overt behavior can be tripped by impulses from reverberating circuits whose activity conforms to universals as well as by impulses coming immediately from an external particular event, the behavior of men can be, and causally is, determined by embodiments of ideas as well as by particular environmental facts."

If brain waves do indeed represent the sweep of cortical scanning circuits it is easy to understand their disappearance in the act of attending to visual experience. Thus attending to sights or even recollecting visual experiences causes them to disappear as the sweep of television scansion is obscured by the formation of pictures. Asynchrony of the nonspecific sweep afferents with the specific sensory circuits might be expected to obscure consciousness and indeed we do find consciousness lost when the brain rhythms show random slow wave activity, or when epileptic discharges take place in the form of abnormally large synchronized bursts of activity. However, it is nonetheless possible to modify profoundly the alpha frequency without appreciable effect on perception or coordinated behavior. This fact is hard to reconcile with the need for precise synchrony of specific afferent patterns of continuous circuits as epistemic correlates of ideas and sweep frequencies of scanning circuits. Thus, hyperventilation can slow the dominant brain wave frequency from 10 cycles per second to 3 and on the other hand flickering light can increase its frequency from 10 to 30 per second without observable modifications of memory, consciousness or of perception in healthy persons (Figs. 6 and 7). However, it is also interesting that both of these procedures can produce seizures in some epileptic patients with attendant loss of consciousness. We might expect modification in the sweep of scansion to produce changes of this kind in everyone, but changes are the exception and not the rule. Failure to modify perception would appear to be possible only if the frequencies of all the reverberating circuits concerned with specific sensory afferents were equally affected by the agents affecting the scanning frequency of the nonspecific associative afferents. But it is hard to see how such uniform synchrony would be possible over wide association areas of the brain, many of which experimentally show different thresholds of susceptibility to chemical agents and which may not be appreciably affected by a stimulus such as a flickering light that drives the neurones concerned with visual reception.

The hypotheses of Wiener and his colleagues are highly suggestive. It will be interesting to observe their impact on experimental physiology during the next decade.

It would be agreed, I am sure, that one of the most significant physiologists of our time is Sir Charles Sherrington and a quotation from his book *Man: on his nature* (*12*) is an appropriate conclusion to a paper on waves and rhythms in the nervous system. In language of singular charm, it pictures the brain asleep and awake. Imagine

> "A scheme of lines and nodal points, gathered together at one end into a great ravelled knot, the brain, and at the other trailing off to a sort of stalk, the spinal cord. Imagine activity in this shown by little points of light. Of these some stationary flash rhythmically, faster or slower. Other are travelling points streaming in serial lines at various speeds. The rhythmic stationary lights lie at the nodes. The nodes are both goals whither converge, and junctions whence diverge, the lines of travelling lights. Suppose we choose the hour of deep sleep. Then only in some sparse and out-of-the-way places are nodes flashing and trains of light points running. The great knotted headpiece lies for the most part quite dark. Occasionally at places in it lighted points flash or move but soon subside.
>
> "Should we continue to watch the scheme we should observe after a time an impressive change which suddenly accrues. In the great head end which had been mostly darkness spring myriads of lights, as though activity from one of these local places suddenly spread far and wide. The great topmost sheet of the mass, where hardly a light had twinkled or moved becomes now a sparkling field of rhythmic flashing points with trains of travelling sparks hurrying hither and thither. It is as if the milky way entered upon some cosmic dance. Swiftly the head mass becomes an enchanted loom where millions of flashing shuttles weave a dissolving pattern, always a meaningful pattern though never an abiding one. The brain is waking and with it the mind is returning."

Based on an address given at the Symposium on Waves and Rhythms held on September 16, 1948 in Washington, on the occasion of the Centennial Celebration of the American Association for the Advancement of Science.

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Polarization of Light From Distant Stars by Interstellar Medium

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IN THE COURSE OF PHOTOELECTRIC OBSERVATIONS made last summer with the 82-inch telescope of the McDonald Observatory (University of Texas) the writer found that the light from distant galactic stars is polarized. Polarizations as high as 12 percent were found. The plane of polarization appears to be close to the galactic plane in the cases examined. More recently control measures were made at the Lick Observatory, thanks to the courtesy of Director Shane and Dr. G. Kron; and during December the work at the McDonald Observatory was extended to different regions of the Milky Way.

In view of the unexpected nature of this result the circumstances leading to its discovery are recorded. Photometric observations for the detection of partially polarized radiation from eclipsing binary stars have been in progress at the Yerkes Observatory for several years with a view to establishing observationally the effect pointed out by Chandrasekhar that the continuous radiation of early-type stars should be polarized (*1*, *2*). On the assumption that the opacity of early-type stars is due to scattering by electrons, the continuous radiation emerging from a star should be polarized with a maximum of polarization of 11 percent at the limb. Since the presence of this polarization can be detected only when the early-type star is partially eclipsed by a larger-type companion of the system, the effect is masked by radiation from this companion so that the expected maximum observable effect was only of the order of 1.2 percent in one case investigated (RY Persei).

At this stage Dr. John Hall, of Amherst College, proposed to the writer a program of collaboration whereby Dr. Hall would construct a "flicker" photometer which was to be tested jointly at the McDonald Observatory. Independently the writer was developing his own equipment which used polaroids. Dr. Hall's equipment was tested in August 1947, during a short session at the McDonald Observatory, but no dependable results were obtained and it was found that the equipment had to be remodeled. Unfortunately, Dr. Hall was unable to come for a second trial period, scheduled for August 1948.

Meanwhile the writer's own equipment was completed and put to use during the summer of 1948 and was found satisfactory. Certain Wolf Rayet stars which were known or suspected to be eclipsing binaries were examined for polarization. Fairly large polarizations were found, but *they did not appear to depend on the phase of the binary motion.* The possibility of instrumental polarization was considered, of course, but ruled out by control measures on check stars. The Wolf Rayet stars give the following results:

Star	*Polarization*	
	%	Position angle
CQ Cep	10.0	62°
BD 55°2721	8.0	44
WN Anon*	12.5	44

*Coordinates: $22^{h}08^{m} + 57°26'$ (1945); 12.5 magnitude.

The control stars had similar color and brightness, but showed no polarization except for one object, BD 55°2723, which gave 3 percent. This star, however, is a giant and more distant than the other control stars. Similar observations made on a group of Wolf Rayet stars in Cygnus showed no appreciable polarization, while two stars in Scutum gave positive results. Other regions, such as the double cluster in Perseus, also show polarization with values ranging up to 12 percent.

We conclude from the positive and negative results quoted that the measured polarization does not arise in the atmospheres of these stars but must have been introduced by the intervening interstellar medium. If this conclusion is accepted, a new factor in the study of interstellar clouds is introduced. Further observations are in progress for relating this phenomenon with other observable characteristics of interstellar medium. As has been stated, the results already at hand indicate that the plane of polarization approximates the plane of the galaxy.

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Observations of the Polarized Light From Stars

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PHOTOELECTRIC OBSERVATIONS of the polarization of starlight made during the period November 1948 to January 1949 with the 40-inch reflector at Washington substantiate the hypothesis of W. A. Hiltner (*2*) that this effect is produced by interstellar matter. Furthermore, the percentage of polarization appears to be independent of wavelength; and the plane of polarization (plane containing the magnetic vector and the line of sight) appears to have no one preferential orientation.

The observations were obtained with a photoelectric polarizing photometer (*1*) built at Amherst College in 1946 with the aid of a grant from the Research Corporation of New York. The light from a star is collimated and directed through a cover glass, which serves as a calibrating device, and then through a Glan-Thompson prism rotated at 15 cycles per second to a 1P21 photomultiplier. The 30-cycle voltage developed by the polarized component of the light is selectively amplified and mixed with a phasing voltage in such a way that the d-c output can be impressed as a sine wave on a Brown recorder. The amplitude of this wave is proportional to the intensity of the polarized light, and the phase of maximum defines the plane of polarization. Records of two stars showing large and small percentages of polarized light are shown in Figs. 1 and 2. The vertical lines represent two-minute intervals. The trace during interval *S* is produced by polarized light from the star. During interval *D* a quartz depolarizer is placed in the light path, and *C* is the result when the cover glass is tilted 20° about an axis whose position angle is arbitrarily set at 94°. The starlight was already depolarized during the interval *C*. The plane of polarization is defined by the direction of the light and the axis about which the glass is tilted. A 20° tilt corresponds to 1.4% polarization.

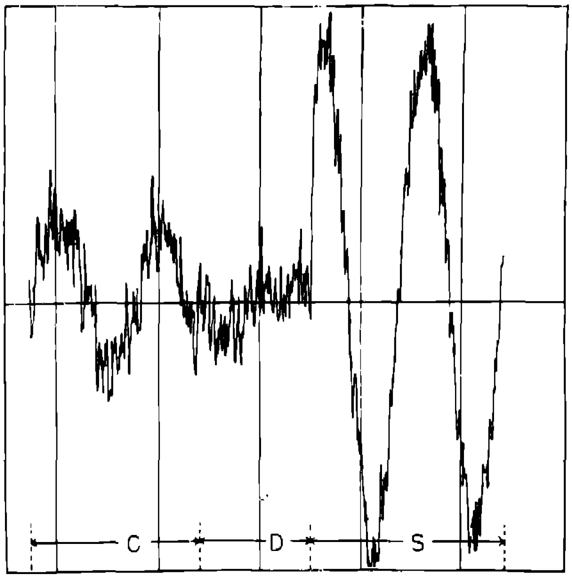

FIG. 1. Star HD 19820, a reddened star of spectral type O8. Polarization, 5.0%; position angle of the plane of polarization, +30°.

The percentages of polarization of the light from 27 early-type stars are shown in Fig. 3 as a function of the color excesses determined by Stebbins and Huffer (*3*). A strong correlation is obvious; the scatter, however, is much greater than the accidental errors of the observations.

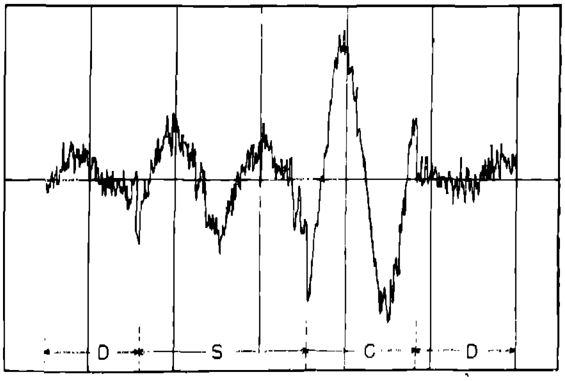

FIG. 2. Star HD 24760, ε Persei. This bright star is not generally considered to be a reddened B-type star. Polarization, 0.5%; position angle, −68°.

The dependence of polarization on color was determined on three nights from observations of ζ Persei using Schott filters UG1 and BG14 for the ultraviolet region and RG1 or a Wratten yellow filter for the red region. The effective wavelengths of the two spectral regions were near 3,700 A and 6,200 A. The observed percentages with the ultraviolet filter were 2.0, 1.6, and 1.8; and with the red filter, 1.6, 1.0, and 2.2. The average value obtained when no filter was used is 1.8 percent. A second star, HD 33,203, was observed on one night, the result being 1.8 in the ultraviolet, 2.2 in the red, and 1.8 with no filter. No definite variation of the orientation of the plane of polarization with color is indicated by these observations.

Fig. 4 shows the observed planes of polarization for 28 early-type stars. The amount of polarization and the orientation of the plane of each is indicated by the length and direction of the line, whose midpoint represents the position of a star. The group of seven stars near the middle of the diagram exhibit a remarkable similarity in percentages of polarization and orientations of the planes, which may be a consequence of the relative homogeneity of the obscuring material in the direction from which their light comes.

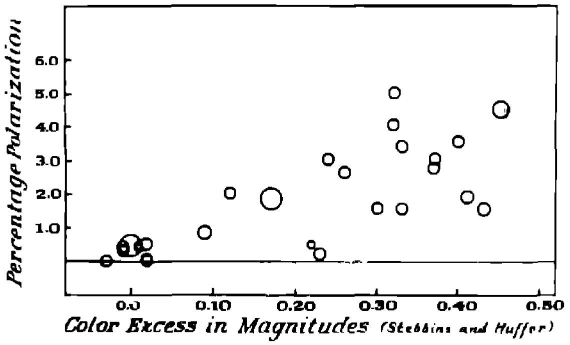

FIG. 3. Observational evidence of a correlation between color excess and percentage of polarization for early-type stars. The size of the circle indicates the weight of the observations.

I have obtained these preliminary results from a project initiated in collaboration with W. A. Hiltner. My grateful appreciation is expressed to Dr. Hiltner and to the Yerkes and McDonald Observatories for the use of the 82-inch reflector for a period of two weeks during the summer of 1947. Despite very unfavorable weather conditions and some difficulty with a new type of photometer, we obtained some evidence of polarization in the light from one star, CQ Cephei. Accordingly it was planned to make a second trial at McDonald during the summer of 1948 with improved equipment, but a second trial could not be made because of other obligations incurred by my transfer from Amherst to Washington on September 1, 1948. With the improved photometer, however, it was easily possible to detect polarization in the light from CQ Cephei with the 18-inch refractor at the Amherst College Observatory. Furthermore, these observations, made during the summer of 1948, showed little if any change in the amount of polarization with the phase of this eclipsing binary star. Meanwhile, Dr. Hiltner's independent work presumably had progressed so far that he did not feel justified in accepting my proposal, made in November 1948, to prepare a joint paper on our work.

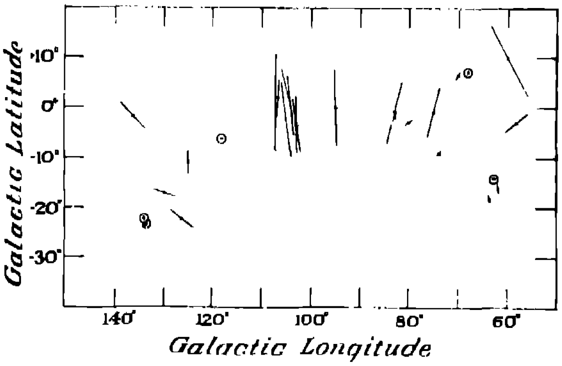

FIG. 4. Observational evidence that there is no one preferential orientation of the plane of polarization. Stars showing no polarization are represented by circles.

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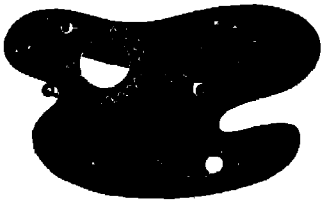

TECHNICAL PAPERS

Structural Control in the Formation of Gneisses and Metamorphic Rocks[1]

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Field work in the Laramie Range, Wyoming, has led to the concept of migration of chemical elements along planar features such as layering, schistosity, and subparallel, closely spaced fractures in the host rock. Gneissic structure may develop along and parallel to these planar features. Plotting the poles of these planes (as shown by strike and dip) on Schmidt hemisphere projections and plotting the composition of the rocks which the poles represent make possible an exact comparison of lithologic composition and structural attitude. A large number of such projections have been made of Pre-Cambrian rocks in Wyoming and Colorado. The results indicate a surprisingly close control of composition of the "guest" by structure of the host. Stress with uniform orientation over regions of hundreds of square miles during each "intrusive" period acted to "open" a set or conjugate sets of planes in the host rock. These relict planes in the guest, when projected and contoured in the structural diagrams, give the center or centers of the most open planar features. The centers of the most open structures for each of the succession of intrusions progress linearly across the diagram, indicating progressive shifts in the orientation of regional stress between intrusive periods. The schist facies display similar variations, indicating a close relation between structural attitude and facies of guest. The most open centers (pole concentrations) for the several schist facies march across the diagram roughly parallel to the line followed by the centers of the time succession of intrusions.

Detailed quantitative work on three gneisses in Wyoming gives a striking mineral variation within each one related to an angular variaton of as little as 10° to 20°. The line from basic to more acidic gneiss within each rock unit is roughly parallel to the "time" line of intrusions and the facies line of the schists.

It is in accord with stress-strain theory to suppose that during each spasm of stress, planes of certain attitude would have least normal pressure and thus form "openings," whereas others, differently oriented, would have most normal pressure and thus be the most "closed" planes of the region. The latter should include the host rocks that have suffered least migration of elements. This would be the "closed chemical system" portion of an area, in contrast to the "open chemical system" in the open structure. Data available are adequate for a partly quantitative comparison of structure and composition, but the method may be made completely quantitative.

The viewpoint and method should have wide application in either field or mineral studies of rock facies. In addition to the gneisses and schists that have been mentioned, amphibolites, dolomites, and iron-formation are examples of rocks of variable composition that might be profitably studied. Regional correlation of gneissic rocks is possible. The strain pattern of a region being "intruded" and metamorphosed can now be studied with fairly high precision.

Rate of Nucleation of Solid Particles in a Subcooled Liquid

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There are many instances, particularly in the nucleation of solid particles from a subcooled liquid, in which transformation appears to take place only after a critical amount of supercooling. For example, in the formation of ice from a cloud of water drops, Cwilong (*1*) and Schaefer (*3*) observe snow to form at a critical temperature of about −38° C. Above this temperature, under most conditions, practically no ice is observed, although the cloud cannot be subcooled below this temperature without rapid transformation of the water to ice. It is the purpose of this paper to show that the existence of such a critical temperature is consistent with the theory of nucleation.

According to nucleation theory (*2*, *4*, *5*), the rate of nucleation of solid crystals in a mol of liquid is

$$\dot{n} = (NkT/h)\ \exp\ (-\Delta F^{*}/kT), \qquad (1)$$

where

$$\Delta F^{*} = (16\pi/3)\ \sigma^{3}/\Delta F_{v}^{2} \qquad (2)$$

is the local free-energy change on forming a nucleus of critical size, σ is the solid-liquid interfacial tension, and ΔF_v is the free-energy change per unit volume associated with the transformation.

Approximating ΔF_v as

$$\Delta F_{v} \approx \Delta H_{v}\ (1 - T/T_{0}), \qquad (3)$$

where ΔH_v is the latent heat of fusion per unit volume and T_0 is the equilibrium temperature, the value of $\ln \dot{n}$ is

$$\ln \dot{n} = \ln\ (NkT/h) - 16\pi\sigma^{3}\,T_{0}^{2}/3kT\,\Delta H_{v}^{2}\,(T_{0} - T)^{2}. \qquad (4)$$

The lowest temperature, T_c, to which the liquid can be subcooled is evidently that for which $\ln \dot{n} \approx 0$, giving the relationship

$$\ln\ (NkT_{c}/h) = 16\pi\sigma^{3}\,T_{0}^{2}/3kT_{c}\,\Delta H_{v}^{2}\,(T_{0} - T_{c})^{2}. \qquad (5)$$

When the interfacial tension, σ, is known, the above equation can be solved for T_c, the minimum temperature to which the liquid can be subcooled. Alternatively, when the value of T_c is known, the equation can be solved for the interfacial tension, σ.

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[1] Published with the permission of the Director, Geological Survey, U. S. Department of the Interior, and the State Geologist, Geological Survey, Wyoming.

Consider, for example, the freezing of water, for which the value of T_c is known to be $T_c = -38°$ C. Taking $T_0 = 273°$ K, $T_c = 235°$ K, $\Delta H_v = 80$ cal/cc $= 3.34\ (10)^9$ ergs/cc, the value of the ice-water interfacial tension, σ, determined from equation (5) is

$$\sigma = 32.8 \text{ ergs/cm}^2. \qquad (6)$$

By using this value of σ in equation (1), the rate of nucleation, $\dot{n}$, can be obtained as a function of T:

T° C	$\log_{10} \dot{n}$
0	$-\infty$
−33	−10.80
−34	− 8.33
−35	− 5.98
−36	− 3.82
−37	− 1.84
−38	0
−39	+ 1.70
−40	3.27
−41	4.74
−42	6.10
−43	7.37

It is of interest to note that the rate of nucleation changes by a factor exceeding 10^{18} in a 10° temperature range including T_c as midpoint. T_c, therefore, resembles a critical temperature, in that water cooled to a few degrees above T_c can persist as liquid for many years on account of the small rate of nucleation of ice. However, on lowering the temperature from a few degrees above T_c, the rate of nucleation increases so rapidly that subcooling below T_c is highly improbable.

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The Reduction of 2,3,5-Triphenyltetrazolium Chloride by *Penicillium chrysogenum*[1]

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The use of the tetrazolium salts, especially 2,3,5-triphenyltetrazolium chloride, to indicate cell viability is apparently well established. Triphenyltetrazolium chloride (TTC) has been used to indicate the germinability of seeds (*3*), and as a histological agent and a reagent in rapid penicillin assays with *Staphylococcus aureus* (*4*). Its use as a reagent in physiology depends upon the enzymic reduction of the soluble colorless triphenyltetrazolium salt to an insoluble carmine red formazan. At this laboratory TTC has been used in studies on the physiology of the penicillin-producing strains of *Penicillium chrysogenum*.

Penicillium chrysogenum Q176 was grown in shaken flasks of 2% corn steep solids–2% lactose medium after the manner described by Koffler, *et al.* (*2*). After harvesting, the pellets were washed free of pigments and nutrients, suspended in M/15 phosphate buffer, and torn apart by a 5-sec treatment in a Waring Blendor. After blending, a buffer solution of the dye was added to give a final concentration of 0.5% TTC. The buffer used throughout was at pH 7.2–7.4, because the reduction of the dye was retarded at a lower pH and was virtually stopped at pH 6.

Under these conditions the most active mold cells would reduce the dye to a deep red color in 20 min at 30° C. Table 1 shows the relative ability of *Penicillium chrysogenum* Q176 of different ages to reduce the dye to a colored formazan and gives the penicillin yields at the time of harvest.

TABLE 1

A Correlation Between the Rate of TTC Reduction and Penicillin Yields by Mycelium of *Penicillium chrysogenum* Q176 at Different Ages

Age of mycelium (Days)	Color	Penicillin yield (Oxford units/ml)
1	deep red	0
2	deep red	0
3	red	0
4	pink-red	0
5	pink-red	42
6	yellow-pink	294
7	yellow-pink	440
8	yellow (color of mycelium)	810

These experiments have been repeated on other penicillin-producing molds with the same results. Thus, if TTC reduction is an indicator of cell viability, it is evident that young nonpenicillin-producing cells (1–3 days old) are much more viable than the older penicillin-producing cells (5–7 days old). In other words, penicillin is formed by the mold when its metabolic state is considerably reduced. That penicillin is formed by the mold when its metabolic state is low or abnormal has been suggested (*1*). These findings with TTC have been checked with the vital stains Nile blue sulfate and neutral red. The cytoplasm of young cells that readily reduced TTC stained deeply and homogeneously, while cells 5 to 7 days old stained unevenly and showed the granules and vacuoles typical of aged cells.

TTC was reduced only inside the cells and the addition of glucose did not change the rate or site of reduction; apparently the endogenous activity of the mycelium was more than sufficient to reduce the dye. The inhibitor KCN inhibited reduction at M/100 final concentration

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and slowed reduction at M/1,000. Sodium malonate, sodium azide, 2,4-dinitrophenol, sodium fluoride, and iodoacetic acid merely slowed reduction at M/100 final concentration. Undecylenic acid, a fungicidal agent, stopped reduction completely. From this lack of specificity for inhibitors it would seem that a number of reducing enzymes acting on materials inside the cell can reduce the dye. Aeration by shaking retarded reduction, perhaps because it raised the redox potential too high (over −0.08 v) or because oxygen competed with the TTC.

Experiments on the reduction of TTC by *Penicillium chrysogenum* have added proof to the theory that penicillin is formed by a relatively inactive mold. Apparently a number of reductases can reduce the dye to the colored formazan. TTC promises to be an interesting and useful reagent in studies on cellular physiology.

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Existence of a Tryptophan-Niacin Relationship in Corn

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The role of tryptophan as a precursor of niacin (nicotinic acid) and its metabolites, especially in the presence of adequate amounts of vitamin B_6, has been demonstrated by recent investigations with mammals (*3, 5–7*). It has also been shown that tryptophan serves as a niacin precursor in the fungus *Neurospora* by way of kynurenine and 3-hydroxy anthranilic acid (*2, 4*). On the other hand, neither tryptophan nor any of its intermediates indicated in *Neurospora* seems to affect niacin production in *Lactobacillus arabinosus* and certain other microorganisms (*10*). It has also been reported that the tryptophan-niacin relationship does not exist in the case of bean seedlings grown without their cotyledons on synthetic media (*9*). The present study, however, indicates that a tryptophan-niacin relationship, like that found for certain mammals and *Neurospora*, may exist in a representative higher plant. Experiments in this laboratory have demonstrated that the addition of L-tryptophan to the nutrient medium results in a significantly increased niacin content in mature excised corn embryos grown in sterile culture.

Seeds of a genetically high-niacin corn (Tennessee Inbred 13)[2] were sterilized with $HgCl_2$ and soaked in water overnight. The embryos (including scutella) were removed intact by sterile excision and transferred to individual Erlenmeyer flasks containing a liquid medium consisting of mineral salts, sucrose, and certain vitamins. Two sets of experiments were conducted.

In experiment I various combination concentrations of L-tryptophan and vitamin B_6 (equimolar quantities of pyridoxine, pyridoxamine, and pyridoxal) were added to each 10 ml (per flask) of the basal nutrient solution. The L-tryptophan and B_6 were previously sterilized by bacteriological filtration. The embryos were grown in the dark at 25° C for 10 days and assayed for niacin by the microbiological method employing *Lactobacillus arabinosus* (*1*). Experiment I reveals (Table 1) niacin synthesis in excess of that of the controls to be a direct function of L-tryptophan supply and to be independent of the concentration of vitamin B_6 employed. On a per-plant basis niacin was increased as much as 64% over the controls when 1,000 µg of L-tryptophan, with various concentrations of B_6, were added to the nutrient solution.

TABLE 1

NIACIN CONTENT OF EXCISED CORN EMBRYOS GROWN FOR 10 DAYS IN DARK WITH VARIOUS CONCENTRATION COMBINATIONS OF L-TRYPTOPHAN AND VITAMIN B_6

Experiment I

Treatment (per embryo)	Number of embryos	Average µg niacin per seedling	µg Niacin per gm dry wt
Control	7	5.07	55.8
100 µg L-tryptophan + 100 µg vitamin B_6	8	6.24	62.7
100 µg L-tryptophan + 50 µg vitamin B_6	6	5.78	60.9
100 µg L-tryptophan + 10 µg vitamin B_6	6	6.32	62.3
Mean		6.11 ± 0.17*	62.0 ± 0.6*
500 µg L-tryptophan + 100 µg vitamin B_6	8	7.44	73.7
500 µg L-tryptophan + 50 µg vitamin B_6	4	6.36	73.1
500 µg L-tryptophan + 10 µg vitamin B_6	9	6.54	70.4
Mean		6.78 ± 0.33*	72.4 ± 1.0*
1000 µg L-tryptophan + 100 µg vitamin B_6	8	8.71	85.7
1000 µg L-tryptophan + 50 µg vitamin B_6	8	8.55	96.3
1000 µg L-tryptophan + 10 µg vitamin B_6	9	7.79	80.0
Mean		8.35 ± 0.29*	89.3 ± 3.5*

* Standard error.

In experiment II the effects on niacin synthesis of L-tryptophan and vitamin B_6 individually, as well as in combination, were studied. The data (Table 2) show that the addition of 1,000 µg of L-tryptophan, singly or in combination with vitamin B_6, resulted in a 35% to 42% increase in niacin synthesis over that of the controls on both a per-plant and a dry weight percentage basis. Statistical examination of these data by use of the *t* test and by analysis of variance (multiple classification) (*8*) show the increase to be highly significant ($P < 1\%$). However, the use of L-tryptophan and vitamin B_6 in combination resulted in only a 7% to 9% increase in niacin production above that obtained by using L-tryptophan alone. This increment is not statistically significant. Nor did the addition of vitamin B_6 alone significantly increase niacin synthesis over that of the controls as checked by the same statistical procedure. The increment was only 3% to 5%. The quantitative differences in the responses of embryos in the two experiments were probably due to the use of seeds from two different crops of the same genetic line.

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[1] Lalor Fellow.

[2] This seed was kindly supplied by Mr. F. D. Richey of the U. S. Department of Agriculture.

TABLE 2

NIACIN CONTENT* OF EXCISED CORN EMBRYOS GROWN FOR 10 DAYS IN DARK WITH AND WITHOUT L-TRYPTOPHAN AND VITAMIN B_6

Experiment II

Treatment (per embryo)	Number of embryos	Average µg niacin per seedling	Average µg niacin per gm dry wt
Control	45	5.22 ± 0.11†	63.4 ± 0.1†
53 µg vitamin B_6	45	5.38 ± 0.16	66.3 ± 1.0
1000 µg L-tryptophan	35	6.60 ± 0.28	85.6 ± 1.5
53 µg vitamin B_6 plus 1000 µg L-tryptophan	40	7.06 ± 0.01	90.1 ± 1.4

* Each niacin value represents the mean of 5 replicated treatments, each treatment involving 7–9 seedlings.

† Standard error.

Niacin assays of the nutrient solutions in which the embryos had been grown indicate that a negligible amount of niacin (< 0.1 µg per plant) was lost by the embryos to the nutrient medium.

It would appear from these experiments with excised embryos that a tryptophan-niacin relationship exists in corn, and that it is independent of added vitamin B_6. Clarification of the role of tryptophan in this relationship, as well as in the normal metabolism of intact corn plants, will be a subject for future investigation. Such information will have added importance in view of the characteristically low tryptophan content of corn.[3]

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A New Method of Freezing Eggs in the Shell and Its Possibilities for Further Application on Freezing Foods in General

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Present methods of preserving eggs by freezing require that the eggs be broken out of their shells, stirred to break the membranes, and stabilized by the addition of some material such as salt or sugar (*9*). The use of this product is limited to bakeries, confectioneries, and similar commercial establishments.

Up to the present time, eggs in the shell have been preserved only at temperatures above the freezing point of water. Ordinary cold storage, a combination of cold storage and gas storage (*7*), and other more or less empirical procedures (*8*) are commonly used. All these methods possess certain disadvantages including displacement of the yolk, weakening of the vitelline membrane, considerable loss of weight, acquisition of off-odors and flavors during storage, and various other minor changes.

A method has been developed in this laboratory for freezing eggs without cracking the shell. This minimizes the above undesirable changes, and the eggs are suitable for home use. Furthermore, the resistance of the embryo to freezing temperatures is increased, as shown by hatchability tests now in progress.

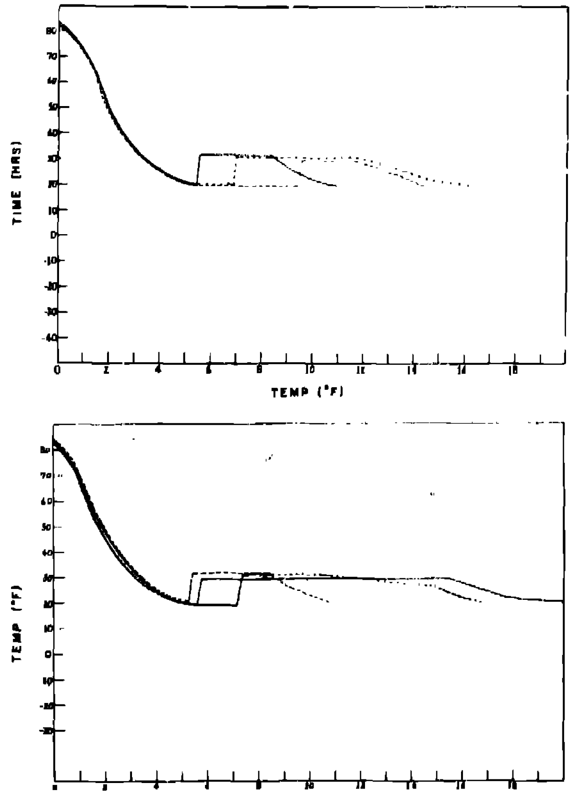
The beginning of the process goes back to 1937, when the author was working on the freezing of mushrooms at the Low Temperature Institute, Cambridge, England. There the idea came to him that if the amount of water corresponding to the expansion of the ice formed by freezing were removed uniformly from the tissues, it would probably prevent the disruption of the cells and obviate blanching. The preliminary tests at Cambridge indicated that this idea, despite the fact that the amount of water to be removed from the mushroom was found to be much more than the amount anticipated, was not without merit. The work was continued with more or less successful results on various other products in the laboratory at the Food Research Experiment Station, Athens, Greece, where the author was in charge until 1945. Meanwhile, in 1939, he obtained a Greek patent (*4*) on a process of freezing foods following partial dehydration which actually is the first original and theoretically established process of dehydrofreezing. The work was interrupted by the war, but resumed in Louisiana in 1946.

Since it appeared that expansion of the ice formed from the water of the tissues was the primary cause of most of the major changes occurring during freezing, a study was undertaken of the mechanism of these changes by associating them with the drip (the liquid exuded from the product during thawing). Adequate methods of measuring the drip have been developed (*5*, *6*), and and by their use it has been possible to accumulate a multitude of data, to be published later, corroborating the validity of the assumption that expansion is the primary factor involved in the changes which occur during freezing. One of the controlling factors in the process of expansion during freezing is the relationship of bound water to free water, which determines also the amount of drip. Dehydration affects this relationship as well as drip, though to a lesser extent in the freezing of eggs than in the case of other products.

TABLE 1

Average Values of Constant Properties of Egg Whites and Yolk Before and After Treatment (to a Loss of 8% Wt)

	Before treatment			After treatment		
	Liquid	Solid	Yolk	Liquid	Solid	Yolk
Percentage of liquid and solid whites	41	59	.....	49	51	......
Refractometer reading	14.63	14.61	48.38	17.17	16.76	48.53
pH	8.32	8.24	6.00	8.89	8.09	6.07
Redox potential millivolts at pH 7.0	+ 158	+ 156	+ 116	+ 139	+ 133	+ 95
Freezing point	− 0.47	− 0.52	− 0.58	− 0.78	− 0.58	− 0.60
Expansion by freezing at 20° F	7.20	7.50	2.5	4.85	5.20	2.40
Bound water	3.22	3.39	5.83	3.45	3.66	0.005



Figs. 1–2. Rates of freezing of the yolk (- - - - -), thick whites (—————), and (. . . . .) thin whites of untreated (top) and treated (bottom) eggs.

In the case of eggs the problem was to reduce the water content to the extent needed to provide space for the expansion of the ice formed by freezing. The necessary decrease in weight based on the water content of the egg and its water-ice curve (3) was estimated to be 6.1%. The actual experiment showed, however, that elimination of a smaller amount (2–3%) was sufficient for freezing eggs under vacuum without cracking. After finding that the treatment does not greatly change the bound water (the amount of which is rather small) of the egg whites and yolk (Table 1), the effect of a vacuum upon the properties of the egg whites and yolk was examined, since

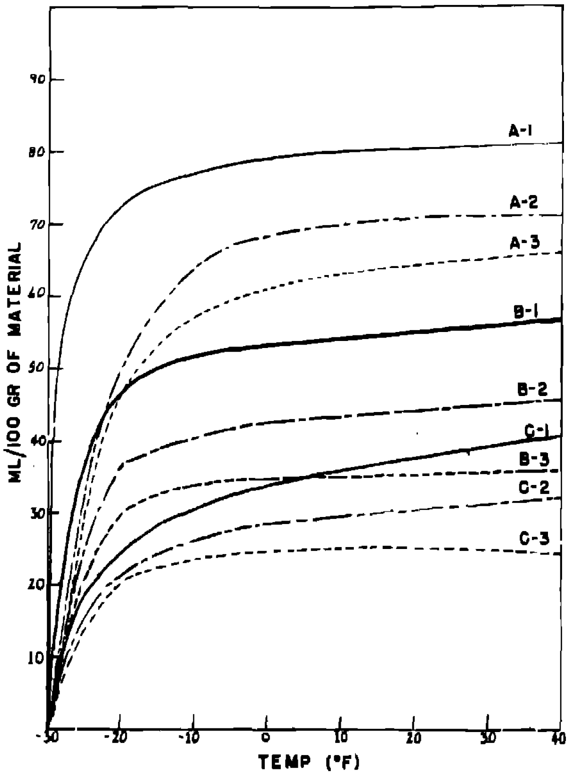


Fig. 3. Expansion of the white and yolk of the egg. A—white: 1, untreated; 2, treated; 3, treated and frozen under vacuum. B—whole eggs: 1, untreated; 2, treated; 3, treated and frozen under vacuum. C—yolks: 1, untreated; 2, treated; 3, treated and frozen under vacuum.

vacuum has been used together with dehydrating agents for the prefreezing treatment. Determinations of the expansion of the egg whites and yolk before and after treatment under vacuum, as well as of their rate of freezing under vacuum, proved tedious until we were able to devise methods which gave reproducible results. The details of these methods will be published later.

The results appearing in Table 1 and graphically in Figs. 1–3 show that freezing treated eggs under vacuum decreases considerably their expansion during freezing and reverses the rate of freezing in the various parts of the egg content when freezing takes place at about 20° F. In the fresh, untreated eggs the white freezes first and creates a solid wall around the yolk, so that when the latter freezes there is no room for expansion and the egg cracks. When the eggs are treated and frozen under vacuum, the yolk freezes first and pushes the white toward the shell so that all the room available in the air space is used during the expansion of the white. This, of course, allows better utilization of the space available within the egg. Removal of the gas from the yolk, on the one hand, and lowering of the freezing point of the white by the treatment, on the other, seem the probable explanation of this surprising result. A contributing factor also is the small decrease in volume of the thick white during the freezing of the treated eggs through a partial breaking down of its mucin content, due probably to the change of pH under the reduced pressure of CO_2 (*1*), a fact which is associated with a change in volume. In one particular case, where the change of thick white to liquid was about 50%, the change in volume was about 3%. All these factors working together help to secure a better economy of space within the egg during freezing and reduce the necessary treatment to a minimum. Under these conditions the treatment does not affect the quality of the eggs at all; on the contrary, the whipping quality of the white is somewhat improved. The loss of weight during storage at 20° F and 85% relative humidity was, in our experiments, 0.15% per month, in comparison with a 0.23% loss obtained during the storage at about 32° F. This loss would be still less if the humidity of the room were kept higher. Eggs kept in an undercooled condition at 23° F for 7 months lost 1.8–2.9% (*10*), and if the theoretical formula developed by Greenlee (*2*) is valid, the calculated loss at storage temperatures below 28° F is zero.

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Reversal to Penicillin Sensitivity in a Cysteine-requiring Mutant of *Salmonella*[1]

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The action of penicillin in producing bacteriostatic and bactericidal effects is believed to be due to chemical interactions with essential SH and perhaps NH_2 groups in the medium (Bailey and Cavalitto, *1*), and so a metabolic block is produced which may be irreversible. Additional evidence for the point of view that penicillin is a metabolic antagonist has recently been given by Wilson and du Vigneaud (*7*), who showed that L-penicillamine—but not D-penicillamine—inhibits the growth of young rats when added to a diet which otherwise permits good growth. When aminoethanol and methylated derivatives were added to the L-penicillamine-containing diet the inhibiting effect of the latter was counteracted. More direct evidence of specific metabolic antagonism is given by Gale and Rodwell (*2*), whose experiments with *Staphylococcus* are interpreted as showing that penicillin acts to impair the ability to assimilate glutamic acid. These investigators have studied the nutritional requirements of penicillin-sensitive *Staphylococcus*, and of resistant strains derived from the original culture by training or mutation. It appears that the parental strains cannot synthesize most of the essential nutrilites, but can concentrate within the cell free amino acids, especially glutamic acid, provided they are available in the surrounding medium. The mutant resistant strains have lost the ability to concentrate free glutamic or other amino acids, but have concurrently developed the power to synthesize all these essential nutrilites within the cell from their inorganic constituents. Since the mutant strains are thus not dependent for growth on the assimilatory processes they should be independent of the antagonistic effects of penicillin, as they are.

These studies still leave many questions unanswered. One of the most obvious concerns the status of the Gram-positive organisms like *Bacillus subtilis*, which are heterotrophic, i.e., synthesize all their nutrilites except glucose, yet are still penicillin-sensitive. It is of considerable interest, therefore, to test the penicillin sensitivity of nutritional mutants of other bacteria, particularly those that are originally penicillin-resistant.

We wish to record one such series of tests in a Gram-negative organism, the results of which give excellent correlation with the metabolic antagonism theory of the action of penicillin. We are studying radiation-induced mutations in *Salmonella typhimurium*, a food poisoning pathogen which is heterotrophic and highly resistant to penicillin. A number of different kinds of mutations

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[1] Supported in part by a grant-in-aid from the American Cancer Society upon recommendation of the Committee on Growth of the National Research Council.

have been studied (Plough, *5*), some of which were isolated by the methods of Tatum (*6*) and show the loss of certain enzyme systems normally carrying on specific essential syntheses, and so require one or more nutrilites in the medium. One of these mutant strains (#10–1) isolated after ultraviolet radiation, requires the amino acid cysteine, which the parental strain can synthesize. Thus we have here exactly the opposite situation from that studied in *Staphylococcus* by Gale and Rodwell. The original *Staphylococcus* is Gram-positive, requires amino acids in the medium, and is penicillin-sensitive. The mutant strains can synthesize their own amino acids and are penicillin-resistant. Our original *Salmonella* is Gram-negative, can synthesize amino acids, and is penicillin-resistant. Our mutant cysteine-requiring *Salmonella* turns out to be much more penicillin-sensitive.

TABLE 1

Medium	International units of penicillin						
	4	2	1	0.5	0.25	0.125	0.062
Original S. typhimurium #511							
Infusion broth	+++	+++	+++	+++	+++	+++	+++
S.D. + Casamino acid	+	+	++	++	++	++	
S.D. + cysteine	−	+	+	+	+	+	+
S.D. + tryptophane	−	+	+	+	+	++	++
S.D. alone	−	+	+	+	+	+	+
Mutant strain #10–1							
Infusion broth	−	−	++	+++	+++	+++	+++
S.D. + Casamino acid	-		+	+	++	++	++
S.D. + cysteine	-	−	−	−	+	+	+
S.D. – tryptophane	−	−	−	-		-	-
S.D. alone	−	+	+	-	+	+	+

The tests were made by the tube method of assay (Plough, *4*), using a graded series of dilutions of penicillin in complete broth medium, and in synthetic medium containing dextrose and essential salts[2] plus particular nutrilites. Growth readings of visible turbidity were made at 24 hours. Results are shown in Table 1.

It is clear that the mutant strain #10–1 is more sensitive to penicillin than the parent strain, both when complete infusion broth medium is used and when the test is made in synthetic medium with complete nutrilites (S.D. + Casamino acid), or synthetic with the essential cysteine (S.D. + cysteine). When synthetic medium and tryptophane or synthetic medium alone is used, the essential cysteine is not present, and so there is no growth, regardless of penicillin.

This result brings *Salmonella* into line with the interpretation of Gale and Rodwell, though the wild type is the opposite of *Staphylococcus*. It further supports the conclusion that penicillin antagonizes the assimilation of one or more amino acids inside the bacterial cell. Study of the mechanism of the metabolic block and of other reactions of other mutant strains is being continued.

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[2] The composition of the synthetic medium (noted in the table as S.D., salts and dextrose) was as follows, after MacLeod (*3*): NaCl 5.00 g; $(NH_4)_2SO_4$ 4.72 g; KH_2PO_4 2.72 g; dextrose 2.00 g; plus 1 ml of a solution containing 1 g each of $FeCl_3$, $MgCl_2$ and $CaCl_2$ in 000 ml. Distilled H_2O was added to make 1 l and pH was adjusted to 7.00 with N NaOH.

When Casamino acid is noted it was "Vitamin-free Casamino acid" Difco, a product hydrolyzed from casein.

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Inhibition of Salt Accumulation in Excised Wheat Roots by 2,4-Dichlorophenoxyacetic Acid

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Widespread interest in the growth effects of 2,4-dichlorophenoxyacetic acid (2,4-D) has led to a number of investigations designed to reveal its mechanism of action. Perhaps the most obvious metabolic effect observed is the striking decrease in the reserve carbohydrates of the treated tissues (*5*). More recently, changes in the respiratory activity of treated tissues have been reported. Brown (*1*) found significantly increased CO_2 evolution by bean seedlings 1 to 4 days after application of 2,4-D spray. Hsueh and Lou (*2*) report a stimulation of germination of rice and barley seedlings at concentrations of about 100 ppm of 2,4-D and, at higher concentrations (up to 1,000 ppm), inhibition of both germination and respiration. Increased CO_2 evolution by the roots of dandelion plants 5 to 15 days after the plants had been sprayed with 2,4-D mixture was observed by Rasmussen (*7*). Taylor (*10*) made detailed studies of O_2 uptake and CO_2 evolution of wheat and mustard seedlings (18 to 30 hrs old) treated with 2,4-D solutions of from 0.25 to 10 ppm. Manometric measurements over a period of 24 hours principally revealed decreases in both O_2 and CO_2 exchange in the two types of seedlings. Studies of Smith (*8*) on the stems of 2,4-D-treated bean seedlings show increases in the respiratory activity of treated tissue when calculated on a dry weight basis but decreased activity when calculated on protein-nitrogen basis. Control tissues were found to be significantly more sensitive to iodoacetate than 2,4-D-treated tissues under anaerobic conditions. Worth and McCabe (*12*) compared the effects of 2,4-D on the growth of several species of aerobic, facultatively anaerobic, and anaerobic bacteria. Growth of the aerobic organisms was greatly inhibited in 3 out of 4 organisms by concentrations of from 0.2% to 2% 2,4-D. Facultative anaerobes were not inhibited at any concentration and were stimulated at concentrations of from 0.002% to 0.2% in all cases. Growth of anaerobic bacteria was inhibited over a wide range of concentrations of 2,4-D.

Preliminary results of studies concerned with the effect of 2,4-D on salt accumulation, which developed from a study of the effect of this compound on nitrate assimilation, are reported below. Excised roots of 4-day-old wheat seedlings were used as plant material. During the growing period the seedlings were supported on Fiberglas gauze stretched tightly over a 2-liter Pyrex crystallizing dish which contained 0.0001 M $CaSO_4$. The cultures were aerated and the vessels were kept in a dark room maintained at 22.0° ± 0.5° C. The plants were grown from White Federation 38 seeds harvested in the Sacramento valley of California in 1945. Plant material in each experimental flask consisted of 45 root segments, each 15 mm long, of which 20 were root tips and 25 were from more mature sections of the root. Because a less sensitive method for the chloride determination was used, it was necessary to employ samples of 35 root tips plus 100 of the mature sections in the experiments on chloride accumulation.

TABLE 1

Time (hrs)	Treatment*	NO_3 absorbed (meq × 10^{-3})	Percentage of control
3	KNO_3	0.50	100
	KNO_3 + 2,4-D	0.20	40
6	KNO_3	2.30	100
	KNO_3 + 2,4-D	0.60	26
9	KNO_3	3.35	100
	KNO_3 + 2,4-D	0.90	27

* KNO_3, 0.001 M; 2,4-D, 10 ppm.

For the experiments, the root samples were placed in 5 ml of solution containing 0.001 M KNO_3 or 0.01 M KCl, with various additions, and aerated by shaking in a constant temperature bath at 25° C for 6 hrs. In the nitrate experiments, the culture solutions were decanted from the roots, and the roots washed 3 times at the end of the experiment. Nitrate analyses were made on the combined culture solutions and washings and separately on the roots. The phenoldisulfonic acid method was used following a modification of Burström's procedure described earlier (*6*). Although only culture solution analyses are reported in this paper, analyses on both roots and cultures were necessary to determine the effect of the treatments on the reduction of the nitrate. In the experiments reported below there was no significant nitrate reduction in any treatment. Chloride analyses were made according to Fajan's method (*11*) on an aliquot of the culture solution. The 2,4-D used was recrystallized twice from a commercial preparation and melted at 134 to 135° C (uncorrected).

Results of a time study (Table 1) show a marked inhibition of nitrate absorption by 10 ppm of 2,4-D within 8 hrs. This effect is clearly a primary 2,4-D inhibition of the accumulation mechanism and not a secondary effect following upon a general metabolic disturbance. In Table 2 it may be seen that concentrations as low as 0.1 ppm are inhibitory. Maximum inhibition was attained with 5 ppm. An attempt to determine the effect of pH on the toxicity of 2,4-D unexpectedly revealed that KH_2PO_4 at 0.001 M (used as a buffer) enhances the 2,4-D inhibition of nitrate accumulation very markedly (Table 3). In the presence of 0.001 M KH_2PO_4, 1 ppm of 2,4-D restricted the uptake of nitrate to form 4% of the control (pH 4.0) to 14% of the control (pH 6.0). These results should be compared to the effect of the same concentration of 2,4-D alone in 2 other experiments reported in Tables 2 and 4, where uptake of nitrate amounts to 58% and 62% of the controls, respectively. Although the inhibition is greater at the lower pH, the differences in absolute amounts are not large enough to indicate a pH relation conclusively. It will be noted that phosphate did not restrict nitrate uptake in the absence of 2,4-D.

TABLE 2

EFFECT OF CONCENTRATION ON INHIBITION OF NITRATE ABSORPTION BY 2,4-D

2,4-D (ppm)	NO_3^- absorbed* (meq × 10^{-3})	Percentage of control
0.0	1.00	100
0.1	1.65	87
1.0	1.10	58
5.0	0.65	33
10.0	0.70	37

* KNO_3 in all cases, 0.001 M.

TABLE 3

pH of buffer*	2,4-D (ppm)	NO_3^- absorbed† (meq × 10^{-3})	Percentage of control
6.0	0.0	2.60	100
4.0	1.0	0.10	4
5.0	1.0	0.30	12
6.0	1.0	0.35	14

* KH_2PO_4, 0.001 M adjusted to pH; indicated with KOH or H_2SO_4.

† KNO_3 in all cases, 0.001 M.

Attempts to reverse the effect of 2,4-D were made with certain dyes: methylene blue, quinone, and dichlorobenzenone indophenol, as well as iodine, cysteine, sodium sulfide, and a normal cellular substrate, citric acid. The dyes and iodine, all used at 10 ppm, enhanced the inhibitory effect of the 2,4-D to a small degree of questionable significance. Sodium sulfide (pH 6.0) at 1×10^{-3} M killed the roots; at 1×10^{-4} M its effect was not significant. Cysteine at 1×10^{-4} M had no significant influence. Citrate alone was able to reverse the 2,4-D inhibition. Its reversal activity was demonstrated in the presence of 1 ppm of 2,4-D and in a second experiment in which the roots were presoaked for 2 hrs in a solution of 25 ppm of 2,4-D, washed, then placed in KNO_3 with and without added citrate. The citrate concentration was 0.05 M in both cases and adjusted to pH 5.0 with KOH.

TABLE 4

Reversal of 2,4-D Inhibition

Treatment*		NO_3^- absorbed (meq × 10^{-5})	Percentage of control
KNO_3		2.50	100
KNO_3 + 2,4-D		1.55	62
KNO_3 + 2,4-D + K citrate		2.45	90
Pre-soaked in 2,4-D‡	KNO_3	1.40	64†
	KNO_3 + K citrate	3.40	154†

* KNO_3, 0.001 M; 2,4-D, 1 ppm; K citrate, 0.05 M, pH 5.0.

† Based on average amount of KNO_3 accumulated by 45 root segments (controls) in 6 hrs, from 6 experiments.

‡ Roots aerated in a solution of 25 ppm of 2,4-D for 2 hrs.

Experiments with KCl, one of which is reported in Table 5, indicate that the 2,4-D inhibition of accumulation is not a specific nitrate effect.

It was felt that the 2,4-D inhibition of salt accumulation might be associated with a lower respiratory activity in the treated roots. Oxygen consumption by 45 root segments at 25° C was measured in a Warburg respirometer. The lower initial values in the third test (Table 6) are probably due to the fact that in this case, after they were cut, the roots stood 3 hrs in redistilled water before they were placed in the vessels. In the first 2 tests the roots were placed in the vessels as soon as they were cut.

TABLE 5

2,4-D Inhibition of Chloride Absorption

Treatment	Cl absorbed (meq × 10^{-2})	Percentage of control
KCl (0.01 M)	1.37	100
KCl (0.01 M) + 2,4-D (10 ppm)	0.70	48

Machlis (*4*) observed a similar effect with barley seedling roots. It may be seen that the oxygen consumption by roots after 5–7 hrs is significantly greater in KNO_3, KNO_3 plus 2,4-D, and 2,4-D alone than it is in distilled water. Differences in oxygen uptake between the roots in KNO_3, KNO_3 plus 2,4-D, and 2,4-D alone are probably not significant in these experiments though it is possible that more intensive studies might reveal such differences. It appears that the inhibition of salt accumulation by 2,4-D cannot be as conclusively related to diminished oxygen consumption as can its inhibition by various respiratory poisons as described by Machlis (*4*).

The results of the present investigation suggest that 2,4-D brings about a change in the relative amounts of energy released by the various possible respiratory pathways or components. Salt accumulation, for example, might be affected by the 2,4-D inhibition of a particular respiratory component. Lundegardh (*3*) has, indeed, presented evidence for the occurrence of two respiratory systems in plant tissues, a cyanide-insensitive system which he calls the "ground respiration" and a cyanide-sensitive system which he designates the "anion respiration." The latter component he associates with salt accumulation. As a consequence of the postulated inhibition of a particular respiratory pathway by 2,4-D and in order to account for the fact that oxygen consumption is not appreciably affected, it might be suggested further that as one component of the respiration becomes less active a second one may assume greater activity.

Another general mechanism for the inhibitory effect of 2,4-D on salt accumulation is suggested by recent work with azide. Spiegelman, Kamen, and Sussman (*9*) studied the inhibition of anaerobic synthesis in yeast by azide. These investigators suggest that azide uncouples anaerobic oxidation of carbohydrate from synthesis by a replacement reaction which prevents the formation of adenosine triphosphate. The suggestion that an uncoupling of oxidation and phosphorylation may likewise be involved in the 2,4-D inhibition of salt accumulation is supported by the observation that oxygen consumption of the roots is not diminished even though the accumulation is inhibited by 2,4-D.

TABLE 6

Test No.	Hour after experimental treatment	Oxygen consumption, mm³/hr/45 root segments*			
		KNO_3	KNO_3 + 2,4-D	2,4-D only	H_2O only
1	1st	64.5	64.5	65.8†	64.1†
	7th	54.7	53.1	59.7†	43.2†
	Change	− 10.8	− 11.4	− 6.1	− 20.9
2	1st	53.7	61.5	63.4†	53.9†
	5th	62.6	61.5	63.5†	39.4†
	Change	+ 8.9	0.0	+ 0.1	− 14.5
3	1st 3 hrs	49.9†	...	47.3	45.9
	5th	56.8†	...	52.2	44.7
	Change	+ 6.9	...	+ 4.9	− 1.2

* KNO_3, 0.0025 M; 2,4-D, Test 1, 5 ppm; Test 2 and 3, 10 ppm.

† Only one vessel in each experiment for these treatments; other rates are average values for two vessels.

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Comments and Communications

Directory of Latin-American Scientific Institutions

During the eight years that the Committee on Inter-American Scientific Publications has been in operation a large amount of information has been accumulated on the academies, universities, scientific societies, and other scientific institutions, both private and governmental, for all of the Latin-American countries. The readers of *Science* may be interested to know that with the aid of a small grant from the Pan-American Union this material is now being assembled into a Directory, which will be available in printed form later this year. We have had the assistance of prominent scientists as editorial advisers in each country; consequently, it has been possible to report in considerable detail on the structure of the faculties of the leading universities.

A report on the history and general activities of the Inter-American Committee is in preparation.

HARLOW SHAPLEY, *Chairman*, and
CHRISTINA BUECHNER, *Executive Secretary*
28 Newbury Street, Boston, Massachusetts

Direct-writing Instruments for Radiocardiography

In Prinzmetal's article on radiocardiography (*Science*, September 24, 1948, p. 340) mention is made of a direct-writing counter used in this work; however, there is no description of the apparatus per se. In no article, nor in conversation with members of the Instrumentation Branch of the AEC, have we been able to find adequate descriptions of such apparatus.

We have devised direct-writing instruments that are very suitable for this work and are only adaptations of standard laboratory instruments. Anyone interested in radiocardiography may in this short note find some helpful hints for his own use.

Any counting-rate meter type monitoring instrument can probably be used in direct-writing counters. In our laboratory the Victoreen model 263A has been adapted because it happened to be on hand. All that is necessary is that leads be attached to each side of the meter. These leads are then attached to a linear potentiometer, and a portion of the voltage across the potentiometer is fed into the ink-writing or photographing instrument used. We have fed a portion of this voltage into a portable electrocardiograph and into a viseocardiette, obtaining excellent tracings. The only precautions necessary are that the potentiometer have high impedance in proportion to the meter of the monitoring instrument so that most of the current flows through the meter (we use a ratio of approximately 1000: 1) and that only a fraction of the voltage across the potentiometer be used to activate the ECG string or wire. The response of the ECG is linearly proportional to the meter of the monitor over the whole meter range. The moderate sensitivity range of the monitor is best for use with all writing instruments we have used.

We have recently used the same monitor in conjunction with a standard d-c amplifier and ink-writing oscillograph. In this case the leads were set directly into the amplifier input without interposition of the potentiometer. Again the moderate sensitivity range was most desirable. Response of the pen was certainly adequate. Slow speed on the paper feed gave best results.

Any such setup as has been described has some of the following advantages: (1) availability of the parts used; (2) easy adaptability of the instruments; and (3) the use of multichannel ECG machines and ink-writing oscilloscopes, which allows simultaneous determination of results with variation in placement of GM tubes over the precordium and with simultaneous standard ECG records using one pair of leads to the multichannel instrument. (The multichannel oscilloscope needs a pre-amplifier ahead of one d-c amplifier to allow ECG's to be made.)

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The Highest Laboratory in the World

In the November 5, 1948, issue of *Science*, under News and Notes (p. 498) the following statement appeared.

"The highest laboratory in the world, situated on the summit of Mt. Evans, Colorado, at an elevation of 14,156 feet, is currently being used. . . ."

I thought it would be of interest to the readers of *Science* to mention that the highest laboratory in the world is located in Morococha, Peru (a mining town of about 4,000 inhabitants) at an altitude of 14,900 feet. This laboratory belongs to the Institute of Andean Biology, Faculty of Medicine of Lima, and it is used for physiological and clinical investigations relating to the influence of a low pressure environment. At the present time a new and larger building is being completed.

ALBERTO HURTADO[1]
Faculty of Medicine, Lima, Peru

A Suggested Contraction for "Desoxyribonucleic Acid"

I have listened to numerous lectures in which the speaker mouthed the 10-syllabled "desoxyribonucleic acid" from 5 to 25 times. Such terms as "dopa" and "paba" are in common use by scientists. Why, then, could we not designate this important nuclear constituent by the simple and euphonious contraction "*dorna*?"

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Bacteriology Laboratory, Hospital Division,
Medical College of Virginia

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[1] Now visiting medical centers in this country at the invitation of The Rockefeller Foundation.

NEWS and Notes

Charles F. Kettering, a co-sponsor of the Sloan-Kettering Institute for Cancer Research since 1943, has been named the chairman of the 1949 fund-raising campaign of the American Cancer Society, for which a minimum goal of $14,500,000 has been set. The drive is scheduled for April.

Robert Fross Rinehart, director of the Planning Division of the Research and Development Board since last July, has been appointed executive secretary of the Board, to succeed **Lawrence R. Hafstad.**

Parker R. Beamer, Department of Pathology at Washington University Medical School, has been appointed professor of microbiology and immunology and associate professor of pathology at the Bowman Gray School of Medicine, Wake Forest College, effective July 1.

Leon Campbell, Pickering Memorial Astronomer at the Harvard College Observatory, was the guest of honor at a dinner held in Cambridge January 29 and attended by 125 of his colleagues. In recognition of his 50 years' service to astronomy, he was presented an illuminated scroll by Donald H. Menzel, associate director for solar research in the Observatory.

W. R. Hatch has been appointed chairman of the Division of Biological Sciences at the State College of Washington, Pullman. He is succeeded by **Noe Higinbotham** as chairman of the Department of Botany.

Jack R. Ewalt, director of the Galveston State Psychopathic Hospital of the University of Texas Medical Branch, has been made administrator of the Medical Branch Hospitals, succeeding **B. I. Burns**, who has become head of the Municipal Hospitals in Kansas City, Missouri.

Adriance S. Foster, professor of botany at the University of California, has returned to the Berkeley campus from a 6-month trip to South America with an extensive collection of tropical plants from the Amazon jungle. The object of his trip, for which he was awarded a Guggenheim fellowship, was to make a general study of the morphology and anatomy of certain groups of tropical plants. He was a guest investigator at the Instituto Agronomica do Norte in Brazil while working at Belém, near the mouth of the Amazon.

Vincent Salmon, former staff physicist for Jensen Manufacturing Company, Chicago, will head the sonics section of Stanford Research Institute's Physics Research Department. Dr. Salmon will continue his studies on industrial applications of high frequency sound and investigate the relationship of sonics to underwater and aerial acoustics.

Theodora L. Coolis, zoology teaching assistant at the University of Wisconsin for the past two years, was recently appointed biology instructor at Kalamazoo College, Michigan.

Paul F. Shope has been appointed associate professor in the Department of Botany and Plant Pathology of the Oklahoma Agricultural and Mechanical College.

John F. Fulton, Sterling professor of physiology at Yale University School of Medicine, will deliver the 6th Frank Billings Lecture at a joint meeting of the Institute of Medicine of Chicago and the Society of Medical History of Chicago on February 25. His subject, commemorating the centennial of the birth of William Osler, will be ''Osler as a Humanist.''

Henry P. Kalmus, formerly at Zenith Radio Corporation's research laboratory, has been appointed to the staff of the National Bureau of Standards. He will conduct investigations in advanced electronic techniques in the Bureau's Ordnance Research Laboratory.

Robert W. Wood, Johns Hopkins physicist, was made honorary Doctor of Science by Oxford University when he was in England last October.

Visitors to U. S.

Sir Harold Spencer Jones, Astronomer Royal of England, arrived Feb. 7 to begin a 3-month lecture tour of the U. S. His host is S. A. Mitchell, of the Leander McCormick Observatory, University of Virginia.

Godfrey S. Delatour, former staff member of the Universities of Berlin, Frankfort, and Paris, has been named visiting lecturer in the University of Illinois Department of Sociology and Anthropology. Prior to his recent appointment, Dr. Delatour lectured at Columbia University.

Colin White, formerly a lecturer at the University of Birmingham, England, recently accepted a 2-year appointment as assistant professor of physiology in the School of Medicine, University of Pennsylvania. Dr. White's appointment was made with a view to promoting the exchange of teaching and research ideas between the U. S. and other countries.

Grants and Awards

Great Britain's Royal Photographic Society has awarded its 1948 Progress Medal to Loyd A. Jones, head of Kodak Research Laboratories' physics department. Dr. Jones received the honor for his contributions to the use of photographic sensitometry in the manufacture and control of photographic materials. He will go to England in May to deliver the Hurter and Driffield Lecture before the Society.

The University of California at Berkeley has been granted $100,000 by the Rockefeller Foundation for equipping the new **Virus Laboratory** headed by Wendell Stanley, Nobel Laureate who recently joined the faculty. The funds will be available for the three-year period 1949–51. A $15,000 ultracentrifuge is already in use at the laboratory and an electron microscope will be added soon.

Applications for grants from the **Cyrus M. Warren Fund of the American Academy of Arts and Sciences** should be received by the chairman of the Committee, Frederick G. Keyes, Massachusetts Institute of Technology, not later than *April 30.* Grants are made in aid of chemical research—generally for apparatus or supplies, or for the construction of special facilities needed for research in chemistry or closely related fields. Because of limited resources, the amount to an individual is seldom more than $300. Application blanks may be obtained from the chairman.

The Robert Gould Research Foundation of Cincinnati has made a grant-in-aid of $5,000 to The Johns Hopkins University for research in 1949 by E. V. McCollum, professor emeritus of biochemistry, School of Hygiene and Public Health of the University. The fund will enable Dr. McCollum to continue his study of the chemistry of nutrition, particularly the problem of separating amino acids in pure form.

Fellowships

A fellowship in obstetric and gynecologic endocrinology is offered to qualified M.D.'s for work under A. E. Rakoff at the Jefferson Medical College and Hospital. Applicants for the fellowship, which will be available about May 1, 1949, should communicate immediately with Lewis C. Scheffey, Professor of Obstetrics and Gynecology, Head of Department, and Director of Division of Gynecology, Jefferson Medical College and Hospital, Philadelphia 7.

The New York State Department of Health is offering fellowships of $3,600 per year for the training of physicians to qualify for public health positions in the state. The training, for one year or more, is for health officers, tuberculosis physicians, clinical consultants, and laboratory directors. Further information and application forms are obtainable from Franklyn B. Amos, Director of the Office of Professional Training, New York State Health Department, Gov. Alfred E. Smith State Office Building, Albany 1.

Colleges and Universities

The University of Massachusetts has inaugurated an instruction and research program in physiological and chemical aspects of radioactivity. In connection with the safety program, Austin M. Brues, of the Argonne National Laboratory, recently lectured on "Biological Consequences of Radioactivity." The research program, which is aided by the National Research Council's Committee on Maternal Health, is already under way. It involves problems of radioactive phosphorus transfer in relation to sperm metabolism.

Members of the Johns Hopkins University faculty present a televised program each Friday night at 9:00 over the Columbia Broadcasting System network. The series, called "The Johns Hopkins Science Review," offers demonstrations of basic principles in various fields of science and illustrates work being done in the Hopkins research laboratories. The February programs are on insect repellents, art applied to medicine, the human heart, and supersonic flight. Televiewers are invited to send in topics which they would like to see presented.

Frontiers in Chemistry, the 8th annual lecture series of Western Reserve University will be held in Cleveland beginning March 4. The first group of 5 lectures on "Recent Advances in Physical and Inorganic Chemistry" will be given on successive Fridays March 4–April 1 in Room 27 of the Adelbert College Main Building. The second group of 5 lectures will also be held on Fridays—April 15–May 13. Each speaker will present two related lectures, one from 5:15 to 6:05 p.m. and the other from 7:45 to 8.35 p.m. Admission fee to each group of lectures is $10.00. Tickets for individual lectures will not be sold. Approximately 200 tickets are available for each group. They may be purchased at the lecture room on opening night or from the University Registrar, Western Reserve University, 11105 Euclid Avenue, Cleveland 6, Ohio.

Summer Programs

Purdue University announces its second annual Short Course for Mold Technicians to be held July 11–23 on the University campus. The course, under the direction of C. L. Porter, professor of botany, will include the study of mold manipulation and identification, and physiology of fungi. The fee will be $100, including supplies. Further information may be obtained by writing to M. M. McClure, Division of Technical Extension, Purdue University, Lafayette, Indiana.

The University of Pittsburgh Chemistry Department will give summer courses, June 7–August 20, in inorganic, analytical, organic, and physical chemistry, carrying 8 semester credits, the equivalent of a full year's work. If there is sufficient demand, a course in biochemistry may also be given. Students may register for the 4-week (one-semester) or for the 8-week (full-year) work. "The Chemical Elements and Their Compounds," a continuation of last summer's course on "Fundamentals of General Chemistry for Teachers," will be held June 27–August 6. This course carries 2 credits. For further information, write Alexander Silverman, Department of Chemistry, University of Pittsburgh, Pittsburgh 13, Pennsylvania.

Meetings and Elections

The Torrey Botanical Club recently elected the following officers for 1949: president, Edwin B. Matzke, Columbia University; 1st vice president, Charles A. Berger, Fordham University; 2nd vice president, Marion A. Johnson, Rutgers University; corresponding secretary, Jennie L. S. Simpson, Hunter College; recording secretary, Donald P. Rogers, New York Botanical Garden; treasurer, Elva Lawton, Hunter College; editor, Harold W. Rickett, New York Botanical Garden; business manager, Harold H. Clum, Hunter College.

The American Mathematical Society will hold its 443rd meeting on February 26 in the Pupin Physics Laboratory, Columbia University, New York City. The Society's 444th meeting will be held on the same date in Eckhart Hall, University of Chicago, Chicago. The 445th meeting will take place April 1–2 at Duke University, Durham, North Carolina.

An International Conference on Science Abstracting is being convened by Unesco, to meet at Unesco House in Paris June 20–25, 1949. A working paper for the conference is in preparation by Thérèse Grivet, making use of the analytical survey of abstracting services prepared for Unesco by the International Federation for Documentation at the Hague.

In addition to the voting representatives from the United Nations Member States, there will be representatives from many international organizations having special interest in science documentation. Not only representatives of abstracting services but also working scientists, science librarians and documentalists will be invited. Observers are welcome.

The conference will receive and discuss a report on the present state of science abstracting, explore alternative abstracting techniques, and discuss such problems as language difficulties and means for improving the accessibility of publications (inter-library loans, photocopying, etc.). It will also make proposals for improving abstracting service through standardized bibliographies, terminology, and layout, and through greater cooperation among services by subject and language to effect economies and eliminate gaps.

Further information on the conference may be had by writing J. B. Reid, Program Specialist for Scientific Literature, Unesco, 19, Avenue Kléber, Paris 16.

Michigan State College will hold its annual **Dairy and Food Inspectors School** April 4–7. Those interested may obtain full details of the School and a copy of the program from W. L. Mallmann, Department of Bacteriology and Public Health, Michigan State College, East Lansing.

BAAS Meeting at Brighton

The 110th meeting of the British Association for the Advancement of Science, held in the southern England seaside town of Brighton in September last, was criticised by many as formless and lacking inspiration. There was some justification for this view when the inevitable comparisons were made with the highly successful previous year's meeting, held in the Scottish University town of Dundee, where there were 1,750 local members as against Brighton's 150, and where there was an exciting theme, "Swords into Ploughshares," whilst Brighton's meeting had none.

Yet there was a certain cohesiveness at Brighton, due entirely to the masterly presidential address of Sir Henry Tizard, F.R.S. The keynote of his words was the great need to increase industrial productivity, and many of the discussions in the various sections fitted into his lead.

Sir Henry spoke a day after Sir Stafford Cripps, the Chancellor of the Exchequer, had told the powerful Trades Union Congress that Britain needed to use more brain in tackling the problem of productivity. Without referring directly to that speech, Sir Henry (the key figure in Britain in the application of science to social needs, as he was then president of the British Association, and is now chairman of three Government bodies: the Advisory Council on Scientific Policy, the Industrial Productivity Committee, and the Defense Research Policy Committee) proclaimed what "more brain" could do.

Sir Henry made it clear that what was needed was not the general expansion of research—"certainly not the expansion of Government research remote from the everyday problems of industry"— but to apply what was already known. The productivity of labour was far lower than it could be if the results of past research were more resolutely and continuously applied. There was a need, he said, for well-trained management in industry, in which technical efficiency was the concern of engineers and technologists who had intimate contact at all levels with scientists responsible for research and development. In other words, scientific thought and influence should be present in the whole process from research to production and use.

This country needed also to maintain a high standard of teaching in the schools, or the next generation of scientists would suffer. In the long run—Sir Henry went on—the expansion of research would fail to produce the hoped-for result unless education in the higher branches of technology was promoted. Finally, he drew attention to the social problems of great complexity that had arisen from the development of preventive medicine. A growing world population was competing for limited supplies of food, and the numbers reaching the sixth and seventh decades of life was growing greatly. He believed that whatever new comforts and luxuries might be provided in future by the advance of physical science, it was on the development of the biological sciences that the peace and prosperity of the world would depend largely.

On the next day, in his presidential address to the Economics Section, Sir Hubert Henderson rebuked economists who were among "the most extravagant propagandists of go-easy illusions, the most pushing salemen enervating fools' paradises," for not appreciating the magnitude of the effort required by Britain to surmount her economic difficulties. In present conditions, he said, controls were useful and sometimes indispensable.

Another economist, Mr. S. R. Dennison, declared, however, that it was exaggeration to say that almost everything—the effects of the war years, the lack of incentive in inflation conditions, the effect of direct taxation on incentive, and the seller's market for labour, for example—except official exhortation, was directed towards encouraging a slow working pace. The chief cure, then, was to create conditions which encouraged increased effort. There were no simple formulae of technology or organisation which could take its place. The confusion of thought on productivity was, he believed, a factor contributing to the misdirection and waste of resources which were the distinguishing mark of the present situation.

The psychologists agreed that there was a need to create conditions which encouraged increased effort: but their approach was different from that of Mr. Dennison. "The dominating fact in this matter of incentives," said Mr. Nigel Balchin, "is that our old purely financial concepts are bankrupt, that in our world today the nature of incentives is nothing more than the nature of human motivation, that 'workers' are nothing less than the human race, and that 'work' is and must be nothing less than life. It is as simple as that and we cannot avoid the tremendous implications of that simplicity."

He was reinforced by Mr. Adam Curle, who believed we had "to consider the structure and orientation of society rather than specific goals whose impetus will not long outlast, in our adverse environment, their application." And by Professor C. A. Mace, who declared there was no very short-term policy which offered a promise of meeting the present demand for a stronger "will to work." The foundation of a satisfactory incentive system lay in vocational guidance, vocational education, and the organization of a social and industrial order in which cooperation sprang from purposes genuinely shared by those who needed to cooperate.

The problem of productivity is not one that concerns industry alone. It is important also in agriculture: for, as Dr. G. Scott Robertson pointed out, the world is once more facing the problem of want with the passing of the period of plenty. The world's population is increasing by 20,000,000 per annum, and we are pledged to raise the standard of living of backward countries.

Although the situation was grave, Dr. Robertson was not pessimistic. "If a peaceful world were to set itself the task of applying the knowledge we already have in preventing soil wastage by erosion, in increasing production by irrigation, by the application of the exacting knowledge of plant breeding, by application of fertilisers, by the mechanisation of work on the land, not forgetting the electrification of the farm buildings and homes, and by developing rapidly the application of genetical science to the breeding of our farm animals the world over, it would, at a very conservative estimate, be possible to double and even treble our production of food in a relatively short time." The effective application of existing knowledge in Britain and the U.S.A. would raise agricultural output by at least 50 percent.

It was also necessary to cut down the gigantic losses due to the diseases of crops and stocks and the depredation of pests, and insects. Between harvest and consumption there is destroyed every year, by mites, pests and rodents, grain equivalent to all the food traveling into international trade—about 65,000,000 tons.

Sir John Russell, F.R.S., underlined these words by pointing out that while population was steadily increasing, the area of agricultural land was steadily diminishing. "We need a new type of agricultural research," he said, "corresponding to the operational research of large-scale industry. It will be necessary to study closely the methods of the best farmers (who hold more than half the total number of farms and nearly two-thirds of the land). A detailed study of these successful enterprises should show the principles underlying their success and open the way to some advance comparable with that from the three-field system to the Norfolk rotation."

Reports were given by two geneticists—Mr. Gordon Haskell and Mr. H. P. Donald—on inbreeding and hybrid vigour in crop improvement and livestock production. Inbred strains of corn hybridised together produced offspring showing increased vigour, such hybrids often surpassing both parental varieties in yielding capacity. In the U.S.A. 62,000,000 acres out of 90,000,000 under maize were sown with hybrid corn (or maize). The hybrid seed was being introduced into Europe, with good results. The same technique was being used for chickens, with great success.

Dr. Michael Graham described how mathematical theory was being applied to fishing, allowing the proper application of data of fishery research, so as to calculate the yield of a fishery under various rates of fishing and other conditions. One formula had been used with success to forecast certain catches for the past three years.

A grave warning was given by Professor J. D. Bernal, F.R.S., that the extremely rapid increase in the utilisation of materials of all kinds in industry and agriculture was beginning to be on such a scale that it affected the actual available supply of many of the elements and threatened to exhaust their most concentrated deposits in a matter of decades. He described how in an industrial system elements did not remain in any fixed place, but underwent a cycle in which they were combined in different ways with other elements, and where they were concentrated, dispersed, and again concentrated.

A careful examination was needed of every phase of the utilisation cycle in conjunction with that of the whole industrial process, with particular regard to the possibilities of research in making processes, especially the recovery process, economic. The most important new idea, essential to any effective utilisation of the elements, was that no element should be employed where its particular properties were not utilised to the full. One way of ensuring such economic use of elements was by the extension of functional specification to the widest number of cases, that is, not a specification for the use of a certain element, but a specification of the fabrication of a product with such and such physical or chemical properties.

Conservation of manpower was a feature of the discussion of the problems of old age. Describing the aged as "a new reservoir of productive power for the nation," Sir Ernest Rock Carling denied that there was any warrant for persons to retire at 60 or 65. This was dictated on sociological, and not on biological, grounds. The number of healthy and independent old people (6,000,000) completely overtopped the ailing, the sick, and the decrepit (200,000). The disabilities of age could be offset by intelligent adaptation: and at work the old showed less psychological weakness than the young, and were a good steadying factor. To help the individual in ill health, it was not drugs that were needed, but personal effort, bodily and mental activity, occupation, and interest.

Much attention was paid to the role of the colonies in helping Britain to meet her food problems. The geographer here made a special claim for full use of his abilities. "For our own good name," said Lord Rennell of Rodd, "the social geographer must be called in to play his very large part in adapting our changing conceptions of African administration, and in seeking to rationalize the mess which western European nations, including ourselves, have made in the African continent." Many other significant aspects of the Commonwealth were discussed—such as the problem of emigration from Britain and the urgent need for a colonial atlas.

There was much misgiving about the training of the scientist and of the young worker in industry. Professor John Read, F.R.S., in a delightful paper on Specialisation and Culture in Chemistry, showed how bad were the consequences of specialisation. His words have a general application. "We ought at least to take what steps we can to combat the narrowing outlook which now threatens to affect science students at all levels," he said, ‘‘and we ought particularly to bear in mind their social, cultural and spiritual needs.’’ He ended with the words: ‘‘Ending as we began, upon an alchemical note, we realize that the microcosm of man has its roots and being in the macrocosm of the outer world, with which it is one. As Salomon Trismosin wrote in the heyday of alchemy:

> Study now whereof thou'rt part;
> So shalt thou see of what thou art;
> What thou studiest, learn'st and art,
> Of that it is thou formest part.
> All that is around without us
> Is eke within us. Amen."

On the needs of youth in industry, Mr. F. Bray was outspoken. ‘‘What is wanted at the moment,’’ he declared, ‘‘is better accommodation, more up-to-date equipment, more good teachers, good libraries, and good social amenities—indeed all those things which encourage students to make themselves efficient workers and good citizens.’’

In reviewing this meeting for ‘‘The Times’’ of London, I concluded: ‘‘All in all, in spite of the proper absence of a single set theme at the Brighton meeting, it has been made clear that workers in nearly every field of the advancement of science have been turning attention, like Sir Henry Tizard, to the contribution which they can make to remedying the world's material troubles. Yet, at the same time, it has been made equally clear that science goes forward, as it must always go forward, in pursuit of the truth wherever it may lead, and among the chief memories of the Brighton Conference will be such notable events as Sir Lawrence Bragg's classic presidential address to the mathematics and physics section on Recent Advances in the Study of the Crystalline State.

This year the British Association is to hold its meeting in Newcastle, in the North Country. The president is Sir John Russell; and the presidents of the various sections are: Sir Harold Spencer Jones (Physics and Mathematics), Sir Alfred Egerton (Chemistry), Professor W. J. Pugh (Geology), Professor A. C. Hardy (Zoology), Professor L. Dudley Stamp (Geography), Sir Alexander Gray (Economics), Sir Arthur Fleming (Engineering), Mr. M. C. Burkitt (Anthropology and Archaeology), Professor R. A. Peters (Physiology), Professor G. H. Thomson (Psychology), Professor Lily Newton (Botany), Sir F. Clarke (Education), Professor N. M. Comber (Agriculture). MAURICE GOLDSMITH

Deaths

W. D. MacMillan, 77, professor emeritus of astronomy and mathematics, University of Chicago, died November 14.

W. S. Hall, 87, professor emeritus of mathematics at Lafayette College and charter member of the Mathematical Association of America, died December 17.

Vincent H. Morris, 50, chemist-in-charge of the Federal Soft Wheat Laboratory at the Ohio Agricultural Experiment Station, Wooster, died January 17 at Wooster, Ohio.

John E. Weeks, 95, author and professor emeritus of ophthalmology at New York University, died February 2 while vacationing in La Jolla, California. Co-discoverer with Robert Koch of the Koch-Weeks bacillus, Dr. Weeks received the Ophthalmological Research Medal of the American Medical Association in 1929.

Rudolf Samuel, 52, author and professor of physical chemistry at the Haifa Technical College, died in Tel Aviv February 3.

Hans Wollenweber, 69, German plant pathologist, died February 3 in Washington, D. C. Dr. Wollenweber, who had worked in the U. S. Department of Agriculture for several years, came to the U. S. last fall, planning to become an American citizen and continue his research work here.

Henry V. Gummere, 78, emeritus lecturer in astronomy at Haverford College, died February 9 at his Philadelphia home.

A joint U. S.—Australian expedition, sponsored by the National Geographic Society, the Smithsonian Institution, and the Commonwealth of Australia, has recently returned from Arnhem Land, the Stone Age country of northern Australia. The naturalists spent 8 months there (see *Science*, February 20, 1948, p. 190) and brought back a collection of more than 10,000 fish, 350 birds, and 460 mammals—some of them previously undescribed. They also learned much about the customs and relics of the natives. One of the most significant archeological discoveries of the expedition was the complete Stone Age hatchet unearthed by Frank M. Setzler, Smithsonian anthropologist. Countless pieces of chipped quartzite, shaped to a cutting edge, had been found previously in many parts of eastern Australia, as well as Arnhem Land. The discovery of the hatchet—one of the scrapers attached by cement to a handle—established conclusively the use of this tool by the early Australian aborigines.

A new laboratory for studying range-finder performance has been established at the National Bureau of Standards with the cooperation of the Army Ordnance Department. It is under the direction of I. C. Gardner and is equipped with a temperature-controlled test chamber and an optical range finder that simulates a target for eight different ranges under conditions corresponding to a wide range of climate. The new laboratory permits a systematic analysis of the various components of the error of a given range finder and has thus been useful in suggesting improvements in design.

The Naval Ordnance Laboratory's new central unit at White Oak, Maryland, was recently dedicated and is now an integral part of the $35,000,000 project for research in modern armament. Begun during the war, the Laboratory now utilizes 60-odd permanent buildings as well as 34 temporary structures, and has 9 more permanent buildings under construction.

The AAAS Membership Office, 1515 Massachusetts Avenue, NW, Washington 5, D. C., will appreciate any information concerning the present addresses of the following people, all life members, whose names and last known addresses are as follows: A. W. Elliott, New York City; Mary L. Jackson, Pittsburgh; Fred I. Lackenbach, San Francisco; J. D. Marmor, New York City; Shigeo Yamanouchi, University of Chicago.

Luminescent Solids (Phosphors)

H. W. Leverenz

Radio Corporation of America, RCA Laboratories Division, Princeton, New Jersey

IT IS A CURIOUS FACT that man synthesized and used luminescent solids long before detecting luminescence from the natural luminescent solids which have existed on this earth since its genesis. About 350 years ago, the alchemist Casciarolo chanced to heat some native barium sulphate with charcoal and noticed that after exposure to daylight the cooled impure sulphide product glowed feebly in the dark. This mysterious solid, which was called a *phosphor* or phosphoros (Greek, "light bearer"), antedated the discovery of the chemical element phosphorus by about 70 years. Because the similarity of terms has caused some confusion, it should be noted that the luminescence of a phosphor is a solid-phase *physical* (electronic) action which occurs throughout the mass and which may continue indefinitely when the phosphor is in a vacuum; whereas the luminescence of the element misnamed phosphorus results from a gas-phase *chemical* action which occurs only at the surface and which ceases when the phosphorus is consumed or placed in a vacuum.

At the time phosphors were first prepared, daylight was the only known means for their excitation, and so luminescence was observable only when it was excitable by daylight and persisted long enough for the phosphor to be taken into a dark place. With the development of modern electronic and radioactive sources of invisible radiations, phosphors have been used not only for instantaneous detection of ultraviolet, X-rays, cathode-rays, alpha particles, etc., but also as a means of putting these invisible forms of energy to work in television, radar, electron microscopes, "fluorescent" lamps, infrared sniperscopes, X-ray fluoroscopes, and self-luminous dial markings. This article briefly outlines the present status of man-made phosphors, whose variety and capabilities greatly exceed those of the known natural luminescent solids. More detailed information may be obtained from the references at the end of this article.[1]

Before proceeding, it is worth emphasizing that the technology of phosphors, like that of other structure- and impurity-sensitive, electronically active solids (*e.g.*, photoconductors, semiconductors, ferroelectric and ferromagnetic materials), is in the process of growing from the status of an art to that of a science. Our imperfect understanding and control of electronically active solids is caused largely by the practical impossibility of completely segregating (purifying) and rectilinearly arranging (crystallizing) the enormous number of atoms ($10^{23}/\mathrm{cm}^3$) in *real* crystals, so that real crystals are always impure and imperfect to some degree. It is known that the unavoidable imperfections (including impurities) in real crystals sometimes increase and sometimes decrease electronic activities such as excitation, internal ionization, radiative and nonradiative transitions, electron mobility, and trapping. Very often, certain crystal imperfections are incorporated deliberately to promote or suppress a given electronic activity. In the case of phosphors, the highly purified *host crystal* usually has a very small proportion of *activator* impurity which is either added initially or is induced to increase luminescence efficiency. The efficiency increase is generally accomplished by decreasing the proportion of excitation energy dissipated in the crystal as heat.

LUMINESCENCE

There is a maximum characteristic thermal radiation from any solid at a given temperature, T, and *luminescence* may be defined broadly as the production of photon emission in *excess* of this thermal radiation. In contrast with thermal radiation, luminescence emission generally decreases with increasing T and occurs as narrow spectral lines or bands (Fig. 1) whose locations and shapes are relatively insensitive to changes in T. Luminescence is generally a *nonequilibrium* process wherein extraneous photons or charged material particles (electrons, ions, etc.) bombard a material and excite a few of its atoms or groups of atoms (*centers*) to energy levels far higher than those attained by thermal excitation. The excited centers then return to lower energy levels and emit correspondingly high-energy photons.

Distinctive prefixes are used to denote luminescence produced by primary particles which differ in the manner in which they excite phosphors, *e.g.*, visible and near-visible photons excite *photoluminescence*, X-ray and gamma-ray photons excite *roentgenoluminescence*, electrons excite *cathodoluminescence*, and ions, such as alpha particles, excite *ionoluminescence*. The energies of these primary excitant particles generally exceed 2 electron volts (ev), where 1 ev =

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[1] Most of the information in this article is abstracted from the author's book, *Introduction to luminescence of solids*, New York: John Wiley, in press.

1.6×10^{-12} erg $= 3.8 \times 10^{-20}$ calorie $= 23$ kcal mole^{-1} (when each simple molecule has 1 ev), there being no known upper limit (at least to 10^8 ev) to the energy of a primary particle capable of exciting phosphors.

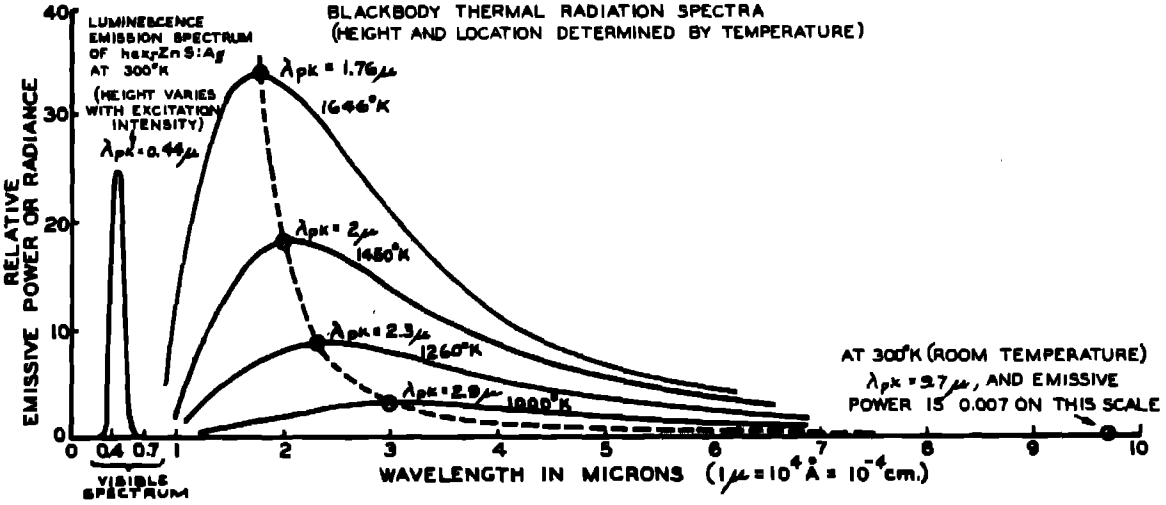


FIG. 1. Comparative spectral distributions of the emissions from a typical phosphor (narrow band at left) and a blackbody thermal emitter (broad bands at right).

The energies of the photons emitted during *conventional luminescence* range from about 1 ev ($1.24 = 10^{-4}$ cm $= 12{,}400$ Å) to 10 ev (0.124×10^{-4} cm $= 1{,}240$ Å), while the energies of emitted X-ray and gamma-ray luminescence photons extend well beyond this range up to about 10^7 ev. This article is concerned chiefly with the conventional visible and near-visible luminescence of solids, which generally involves transitions of the outer or valence electrons comprising the "skins" of atoms. These exposed electrons are sensitive to changes in the kind, number, spacing, and arrangement of neighboring atoms in a solid, and the luminescence of solids is thus a sensitive indicator of changes in composition, impurities or other imperfections, and crystal structure. Also, the valence electrons of an atom in a solid experience most strongly the jostling caused by thermal motion of atoms, so that increasing the temperature of the solid generally perturbs the luminescence process and increases the probability of conversion of high-energy excitation quanta into low-energy thermal quanta (phonons).

With respect to the duration of luminescence, *fluorescence* indicates a normal, unconstrained, spontaneous radiative return from the excited state (as in isolated nonmetastable atoms or ions), whereas *phosphorescence* indicates an abnormally long delay between excitation and emission, using *isolated* atoms or ions as standards of normal behavior. Fluorescence, then, is a limiting case of phosphorescence and corresponds to a natural excited-state lifetime, τ_F, of about 10^{-8} or 10^{-9} second for the nonmetastable excited states of isolated atoms or ions undergoing the optical transitions which occur in conventional luminescence. The natural lifetimes of isolated atoms are determined chiefly by oscillator damping (classically, $\tau_F \propto \nu^{-3} \rho_d^{-2}$ for radiation of photons of frequency ν from a dipole with moment ρ_d), and the width of a fluorescence emission *line* is determined by the indeterminacy of the excited-state energy level, ΔE^*, such that $\Delta E^* \geqq h/\pi\tau_F$, where $h = 6.62 \times 10^{-27}$ erg sec. This line width is only about 10^{-7} ev for conventional fluorescence with $\tau_F \approx 10^{-8}$ second, whereas many phosphors have emission bands nearly 1-ev wide and their emissions persist for seconds or days (*i.e.*, the band widths and persistences of phosphors are often unrelated). Most phosphors exhibit predominantly an abnormally delayed emission, which is called phosphorescence. Here, the abnormal delay may be caused by (1) the strong perturbing (constraining) influence of neighboring atoms on excited centers in solids, and/or (2) internal ionization and trapping. *Internal ionization* is the ejection of an electron from an excited atom or center, without the electron's leaving the solid. The vagrant excited electron may become trapped, particularly near imperfections in the crystal, and remain trapped for an indefinite time before being released by heat or other energy so that it can again wander to make a radiative recombination with an ionized center.

In general, phosphors begin to emit luminescence photons within 10^{-8} second after onset of excitation, but very often much of the excitation energy is stored in the form of prolonged (constrained) excited states or trapped excited electrons so that photon emission is extended for intervals ranging from a few seconds to a few years after cessation of excitation, the duration of phosphorescence depending on the nature of the phosphor and its conditions of excitation and operation. When a large proportion of the excitation energy is stored, the curve of luminescence output *vs.* time exhibits a detectable *growth* (Fig. 2) until equilibrium is established, *i.e.*, until the rate of filling and emptying of excited states and traps has stabilized in the excited volume of the solid. After cessation of excitation, there is a *decay* of luminescence output *vs.* time as the stored excitation energy is released. When there is simple excitation, without internal ionization and trapping, the rate of emission of luminescence photons, L, decreases exponentially with time, t, according to $L = L_0 e^{-at}$, where L_0 is the luminescence output at cessation of excitation and the decay constant a $(= \tau^{-1})$ ranges from about 10^7 to 1 sec^{-1}, depending on the composition and structure of the phosphor. It is to be expected that τ will be larger and, hence, a will be smaller the more constraint an excited emitting atom or center experiences from its neighbors in the crystal, but the emitter itself is a primary factor in determining τ. In this case, the spontaneous *exponential decay* is little affected by changes in the temperature of the phosphor or the conditions of excitation.

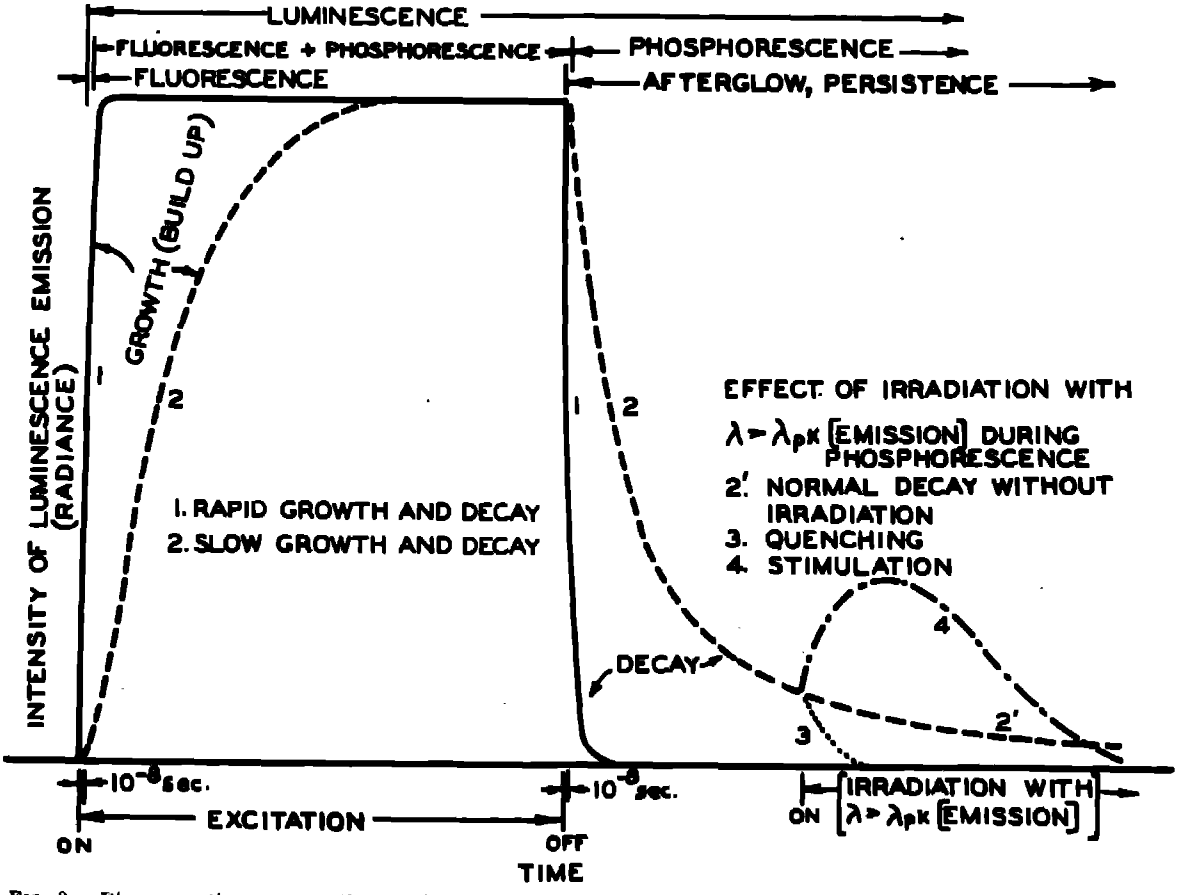

LUMINESCENCE
FLUORESCENCE + PHOSPHORESCENCE
PHOSPHORESCENCE
FLUORESCENCE
AFTERGLOW, PERSISTENCE
INTENSITY OF LUMINESCENCE EMISSION (RADIANCE)
GROWTH (BUILD UP)
1
2
1
2
1. RAPID GROWTH AND DECAY
2. SLOW GROWTH AND DECAY
EFFECT OF IRRADIATION WITH
λ > λpk [EMISSION] DURING PHOSPHORESCENCE
2'. NORMAL DECAY WITHOUT IRRADIATION
3. QUENCHING
4. STIMULATION
4
DECAY
2'
3
10⁻⁸ sec.
10⁻⁸ sec.
EXCITATION
ON
OFF
TIME
IRRADIATION WITH λ > λpk [EMISSION]
ON

FIG. 2. Diagrammatic representation of the dynamics (growth and decay) and terminology of luminescence emission.

The emitting center loses control over τ when the energy storage in phosphors consists of trapped excited electrons or metastable states, for then additional *activation energy* must be supplied to release the trapped electrons. This activation energy may be supplied by heat, especially when the trap depth is equal to or less than about 30 kT (where $k = 1.38 \times 10^{-16}$ erg $deg^{-1} = 8.7 \times 10^{-5}$ ev deg^{-1}), or it may be supplied by additional photons or charged material particles. During ordinary phosphorescence at room temperature the activation energy is supplied by heat, so this process is thermostimulated phosphorescence. Under these conditions, so-called *power-law decays* are observed such that $L \propto L_0 t^{-n}$, where the exponent n is strongly dependent on the phosphor temperature and on the kind, intensity, and duration of excitation; also, n varies during the decay interval. In general, n has values lying between about 0.1 and 2, being near unity for most of the useful phosphorescence times of efficient long-persistent phosphors. The variability of *n* bespeaks the variable degree of filling and rate of emptying of traps of different densities and depths, and the variable occurrence of retrapping, since the density of excitation decreases in a roughly exponential manner as the beam of primary excitant particles penetrates into a phosphor crystal.

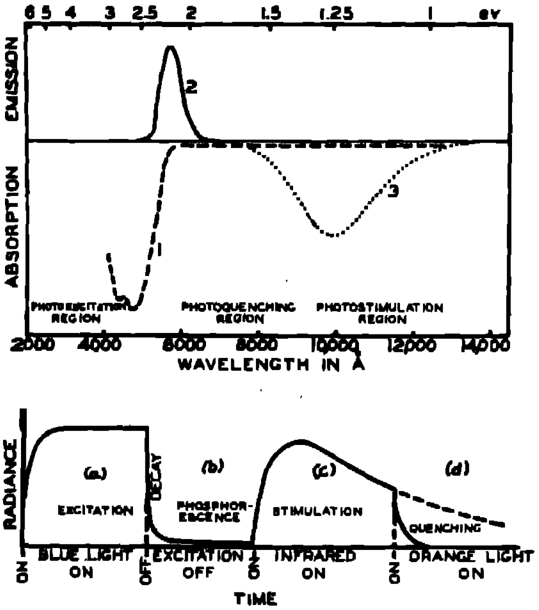


FIG. 3. *Above*: Spectral distributions of excitation, quenching, and stimulation for a cub.-Sr(S : Se) : $SrSO_4$: CaF_2 : Sm : Eu phosphor. *Below*: Dynamics of growth and decay of the above phosphor during and after (a) excitation, (b) decay, (c) stimulation, and (d) quenching.

Infrared is another useful source of activation energy which may (1) be unabsorbed (*i.e.*, be entirely reflected or transmitted) and hence cause no change in the normal decay curve shown as 2′ in Fig. 2, or (2) be absorbed and *quench* the phosphorescence emission, as shown in curve 3 of Fig. 2, or (3) be absorbed and *stimulate* the phosphorescence emission, as shown in curve 4 of Fig. 2. Because the quenching and stimulating effects for a given phosphor vary with wavelength, a broad-band source of red and infrared may act as both a quenching and stimulating agent simultaneously. The top portion of Fig. 3 shows the spectral relationships of excitation, emission, quenching, and stimulation for a complex infrared-stimulable phosphor of the type used in metascopes for infrared detection and signalling. The bottom portion of Fig. 3 shows how the yellow emission band may be produced by excitation with blue light (≈ 4,500 Å), allowed to decay, stimulated by infrared (≈ 10,000 Å), and quenched by orange light (≈ 6,000 Å).

The complex chemical formula (which is really an oversimplification!) for the infrared-stimulable phosphor of Fig. 3 serves as an extreme example of the system of notation used in symbolizing luminescent solids. The chief ingredients of a good phosphor are the host crystal, one or more fluxes (fusible salts, which are not always used), and one or more activators (promoters of luminescence) which may be added deliberately or be induced by decomposition during crystallization at high temperatures. Examples of other useful phosphors and their notations are given in Table 1. According to the indicated simplified notation, a phosphor is symbolized by (1) the crystal system of the host crystal, followed by (2) the chemical formula of the host crystal, then by (3) any fluxes which are *incorporated* in the host crystal (this is not the case in examples 1–3 of Table 1), and finally by (4) the chemical identity of the activator *cation* [placed in square brackets when there is uncertainty as to its identity or presence] with the weight percent of activator cation relative to the weight of the host crystal given in parentheses.

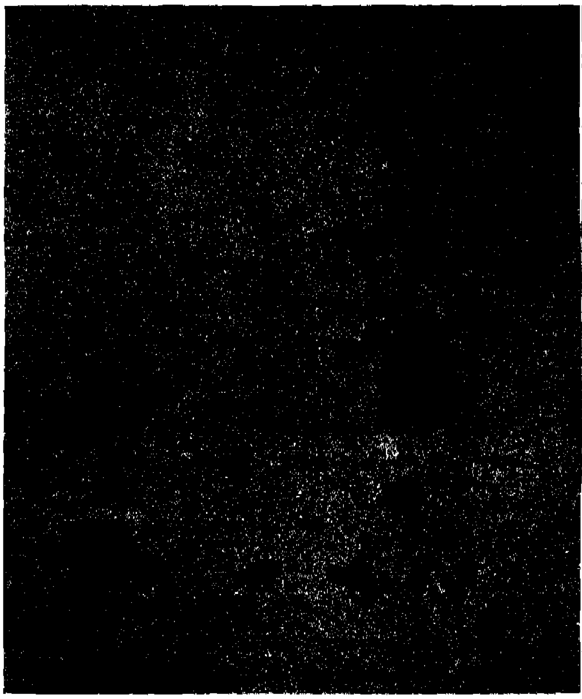
TABLE 1

COMPOSITIONS, PREPARATIONS, AND DESIGNATIONS OF SOME TYPICAL PHOSPHORS

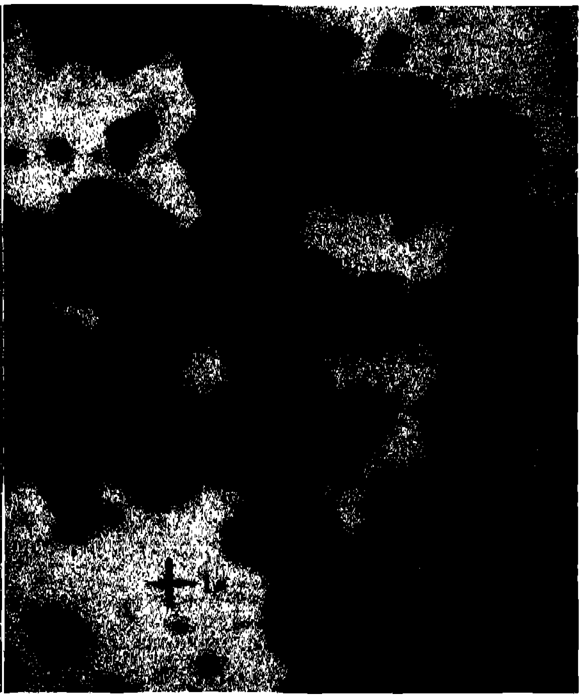
No.	Ingredients			Cryst. temp.	Post-cryst. treatment	Phosphor notation	Decay type
	Host crystal	Flux	Added activator				
1.	1 ZnS (*i.e.*, 97.44 g ZnS)	2 g NaCl	......	1250° C	wash	hex.-ZnS : [Zn]	t^{-n}
2.	1 ZnS	2 g NaCl	0.017 g $AgNO_3$	"	"	hex.-ZnS : Ag(0.01)	"
3.	1 ZnS	2 g NaCl	0.018 g $CuCl_2$	"	"	hex.-ZnS : Cu(0.01)	"
4.	2 ZnO + 1 SiO_2 (102.76 g + 60.06 g)	....	......	"	...	rbhdl.-Zn_2SiO_4 : [Si]	$e^{-at} \longrightarrow t^{-n}$
5.	2 ZnO + 1.02 SiO_2 (162.76 g + 61.26 g)	....	0.02 TiO_2 (1.6 g)	"	...	rbhdl.-Zn_2SiO_4 : Ti(0.4)	"
6.	2 ZnO + 1.012 SiO_2 (162.76 g + 60.78 g)	....	0.012 MnO (1.1 g)	"	...	rbhdl.-Zn_2SiO_4 : Mn(0.8)	"

EXEMPLARY SYNTHESES OF PHOSPHORS

The phosphor compositions given in Table 1 are sufficient to prepare efficient phosphors *if* excep-



a



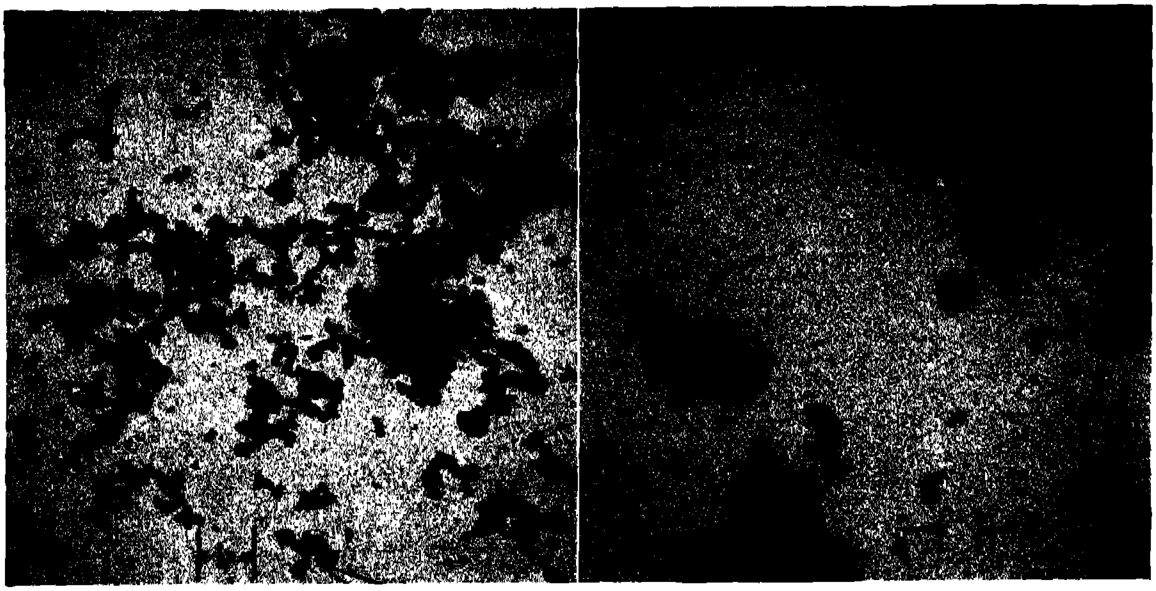
b

FIG. 4a. Electron micrograph of precipitated-and-dried luminescence-pure zinc sulphide.

FIG. 4b. Photomicrograph of hex.-ZnS : Ag(0.015), prepared by heating the fine-particle ZnS shown in Fig. 4a (with activator and about 6-percent halide flux) at 1,250° C.

tionally *pure ingredients* are used (especially when the optimum activator proportion is low), the ingredients are *thoroughly mixed,* and the mixtures, in acid-cleaned, covered, fused-silica crucibles, are *heated* in air to the indicated temperatures for ten to a hundred minutes. These examples are typical of the formation of most phosphors by reactions in the solid state, *i.e.,* reactions between solids at temperatures below their melting points and the melting points of their products. (Growth of phosphor crystals from melts is seldom successful because the melting points of the host crystals are usually so high that the melts react vigorously with their containers and the mixtures tend to decompose and volatilize selectively.) Under these conditions of solid-state reaction, the presence of a flux, such as sodium chloride, sometimes promotes crystallization by providing a fluid phase to facilitate material transport. Fig. 4a shows an electron micrograph of a pure, practically nonluminescent, precipitated-and-dried zinc sulphide, which was used as the initial ingredient in preparing phosphors 1–3 of Table 1. Fig. 4b shows a photomicrograph of the much larger phosphor crystals produced by heating this fine zinc sulphide (with flux) to 1,250° C. These hex.-ZnS : Ag(0.015) phosphor crystals are about 10^8 times larger (in volume and weight) than the initial 250-A ingredient particles. In the case of the zinc-silicate phosphors, no flux is used, and the average particle size of the resultant phosphor is determined largely by the particle size of the initial silica, because the reaction proceeds by diffusion of the zinc and manganese oxides into the silica particles. This is illustrated in Fig. 5, which shows electron micrographs of two different lots of rbhdl.-Zn_2SiO_4 : Mn(0.3) prepared from (a) exceptionally fine colloidal silica, and (b) an ordinary c.p. silica. (The electron micrographs in Figs. 4 and 5 were made by Dr. J. Hillier.)

As may be seen from Figs. 4 and 5, the average particle sizes of useful phosphors are generally a few microns or less, because finely divided ingredients must be used to obtain complete solid-state reaction in a reasonably short time. The small particle size of phosphors is desirable to increase the absorption of primary ultraviolet in "fluorescent" lamps, and to improve the image definition and optical efficiency of television cathode-ray-tube screens, but it makes difficult the determination of certain fundamental physical characteristics such as absorption spectra, absorption coefficients, and conductivities. It is in only a few cases, such as cub.-KCl : Tl, rbhdl.-Al_2O_3 : Cr (artificial ruby), and tetr.-$CaWO_4$: [W] (artificial scheelite), that efficient luminescent crystals of centimeter size have been prepared from their melts. Insofar as the effect of crystal size on luminescence is concerned, the luminescence of phosphors is a *volume* effect, as evidenced by the fact that (1) cathodoluminescence efficiency increases as the penetration of the primary electrons increases, and (2) the two different lots of rbhdl.-Zn_2SiO_4 : Mn(0.3) phosphor shown in Fig. 5 have practically the same efficiency of cathodoluminescence and photoluminescence despite the great difference in their particle sizes.



a b

FIG. 5a. Electron micrograph of very-fine-particle rbhdl.-Zn_2SiO_4 : Mn which was prepared by reaction of zinc hydroxide and manganese hydroxide with colloidal silica.

FIG. 5b. Electron micrograph of commercial rbhdl.-Zn_2SiO_4 : Mn prepared by reaction of the oxides, using conventional pure silica with an average particle size of about one micron.

EFFECTS PRODUCED BY IMPURITIES

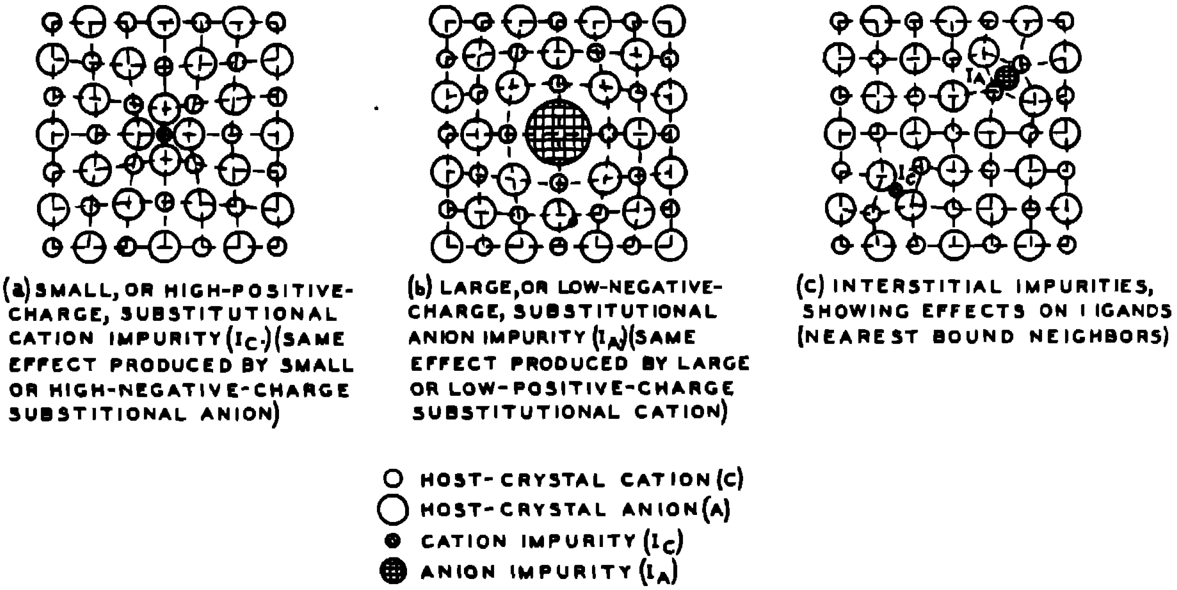
In general, phosphors consist of relatively nonluminescent host crystals containing a small proportion of added or induced impurities. Impurities can form many different local distorted regions (*e.g.*, centers), as depicted in Fig. 6, and a given impurity may: (1) act as an *intensifier activator* by intensifying a weak or latent host-crystal emission spectrum, (2) act as an *originative activator* by producing a new emission spectrum, (3) act as a *sensitizer* by producing a new excitation spectrum without altering the emission spectrum, (4) act as a *trap* by altering the duration and intensity of power-law-type phosphorescence, and (5) act as a *"poison"* (or "killer") by decreasing luminescence efficiency.

These examples illustrate these effects and show how a given impurity may function in several of the following roles.

(1) When very pure zinc silicate is crystallized at 1,250° C, the product is found to have an inefficient cathodoluminescence emission shown as curve 4 in Fig. 7. This emission comes from some of the excited tetrahedral SiO_4 groups which are presumably perturbed by a slight excess of silicon [Si] (or [Zn]?) produced by selective volatilization of oxygen. Here the [Si] acts as an *intensifier activator,* probably by upsetting the selection rules which govern electronic transitions in ideal crystals. When about a percent of titania is incorporated in this phosphor, the same emission band is obtained with about a tenfold increase in efficiency (cf. curve 5, Fig. 7). Here, the titanium (in the combined form!) is an additional intensifier activator. In the same way, silver appears to act as an intensifier activator for zinc-sulphide phosphors, operating to increase the efficiency with only a slight shift and narrowing of the emission band (curves 1 and 2, Fig. 7).

(2) When rbhdl.-Zn_2SiO_4 : [Si] is reheated at 1,250° C with increasing proportions of manganese oxide, the [Si] emission band decreases and a new emission band rises in the green until, at about one percent Mn, only the strong green emission is evident (curve 6, Fig. 7). Here, the Mn (which substitutes for Zn) acts as a *poison* in preventing the [Si] emission, and simultaneously acts as an *originative activator* in producing the new centers which emit luminescence photons with high efficiency. Similarly,

copper activator poisons the blue [Zn] emission band of hex.-ZnS: [Zn] while producing a new green emission band (curve 3, Fig. 7). Present evidence indicates that the best originative activators are added ions, which exhibit more than one formal valence (*e.g.*, Mn^{++}, Mn^{++++} and Cu^{+}, Cu^{++}), whereas intensifier activators may be either added or induced, and need not be multivalent (*e.g.*, [Zn^{++}], [Si^{++++}]; Ti^{+++}, Ti^{++++}; and Ag^{+}, Ag^{++}).


(a) SMALL, OR HIGH-POSITIVE-CHARGE, SUBSTITUTIONAL CATION IMPURITY (I_C) (SAME EFFECT PRODUCED BY SMALL OR HIGH-NEGATIVE-CHARGE SUBSTITIONAL ANION)

(b) LARGE, OR LOW-NEGATIVE-CHARGE, SUBSTITUTIONAL ANION IMPURITY (I_A) (SAME EFFECT PRODUCED BY LARGE OR LOW-POSITIVE-CHARGE SUBSTITUTIONAL CATION)

(c) INTERSTITIAL IMPURITIES, SHOWING EFFECTS ON LIGANDS (NEAREST BOUND NEIGHBORS)

FIG. 6. Examples of typical distortions produced by impurities in host crystals.

(3) When calcium carbonate or calcium silicate is crystallized with about one percent of manganese activator, the phosphors are found to have efficient red-orange cathodoluminescence, but no appreciable photoluminescence under 2,537-Å ultraviolet. If, however, these phosphors are recrystallized with a small proportion of lead oxide in addition to the added manganese oxide, then the same red-orange emission is obtained as before and the phosphors are now readily excited by 2,537-Å ultraviolet. Here the (combined) lead acts as a *sensitizer* which introduces a new absorption band in the spectral region around 2,537 Å.

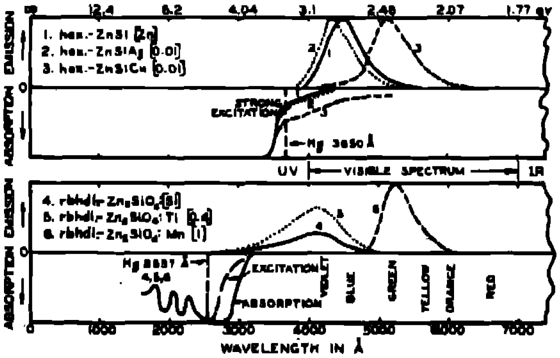


FIG. 7. Spectral distribution of absorption, excitation, and luminescence emission of some typical zinc-sulphide-type and zinc-silicate-type phosphors.

(4) In the previous example of hex.-ZnS: Cu, the multivalent Cu acts not only as a poison and an activator but also as a *trapping agent*. This is evidenced by intense and prolonged phosphorescence at room temperature and by pronounced glow curves (curves of light output *vs.* temperature and time as a phosphor previously excited at very low temperatures is warmed). By incorporating a lead compound in this phosphor, it is found that the lead provides very deep traps, such that the phosphor performs in the same manner as the infrared-stimulable material in Fig. 3. In the case of rbhdl.-Zn_2SiO_4: Mn, it has been found that tin and arsenic compounds are effective in providing traps without altering the emission spectrum of the phosphor.

(5) In addition to the previous examples of poisons, it may be mentioned that manganese in trace amounts is a strong *poison* to the emission of calcium-tungstate phosphors. Also, certain other transition elements, particularly iron and cobalt, are strong poisons in almost all phosphors.

EFFECTS PRODUCED BY CHANGES IN STRUCTURE

The pronounced influence of structural changes on the luminescence of solids is shown in the following examples:

(1) When rbhdl.-Zn_2SiO_4: Mn (denoted as the α-form) is melted at 1,600° C and then quenched, it

crystallizes in a new (β-form; undetermined) structure having a different diffraction pattern. On comparing the α and β products, it is found that: (1) the emission band of the α-form peaks at 5,250 Å, whereas the emission band of the β-form peaks at 5,630 Å; (2) the β-form has about 75 percent of the cathodoluminescence and photoluminescence efficiency of the α-form; and (3) the α- and β-forms have practically identical exponential decay characteristics. On heating the yellow-emitting β-form to about 950° C, it reverts to the green-emitting α-form, demonstrating that the observed effects are caused by changes in structure rather than composition.

(2) When $ZnS:[NaCl(2)]:Ag(0.01)$ is heated at 780° C it crystallizes in the cubic system, whereas on heating at 1,200° C it crystallizes in the hexagonal system. On comparing these two products, it is found that: (1) the emission band of the cubic material peaks at 4,480 Å, whereas the emission band of the hexagonal material peaks at 4,330 Å; (2) the hexagonal material has about four times the peak output of both cathodo- and photoluminescence relative to the cubic material; and (3) although both materials have power-law decays, the intensity and duration of phosphorescence emission of the hexagonal material is much greater than that of the cubic material at room temperature. On grinding, the hexagonal crystals are transformed into the cubic structure.

LUMINESCENCE EXCITATION

When a beam of primary excitant particles impinges upon a phosphor crystal, some particles are reflected, whereas others are transmitted into the interior of the crystal. The energy of a transmitted primary *photon* is absorbed all at once or not at all (neglecting Compton scattering) in one absorption act wherein the photon is annihilated. The energy of a fast primary *electron or ion,* on the other hand, is usually absorbed bit-wise, where the average energy bit is about 25 ev. Differences in excitation processes are evident, also, with respect to *where* the energy is absorbed in a phosphor crystal. Low-energy primary ultraviolet photons often excite phosphor centers directly, because the centers generally have lower characteristic frequencies than the atoms of the host crystal. High-energy primary particles (*e.g.*, X-ray and gamma-ray photons, and fast electrons and ions), however, give up their energies indiscriminately, so that most of their energy is absorbed by the preponderant host-crystal atoms. In this case, the absorbed energy must be transported to the centers and the efficiency of such energy transport depends strongly on the degree of perfection of the crystal. Hence, there are many photoluminescent glasses and crystals with high efficiency, but only highly crystalline phosphors give high efficiency of roentgenoluminescence, cathodoluminescence, and ionoluminescence. The high rate of degradation (into heat) of energy transported in vitreous matter accounts, also, for the fact that only crystalline phosphors give efficient, long-persistent, power-law-decay phosphorescence involving wandering and remote trapping of excited electrons.

It is probable that most of the energy transport in phosphors is by excited "free" electrons, although other means are: positive holes, excitons, photons, and exchange-type energy transfers which occur when the wave functions of atoms and centers overlaps in a suitable manner. Positive holes are residual regions of excess positive charge produced by internal ionization, and excitons are mobile pairs of positive holes and nearly-"free" excited electrons. The problems of energy transport in solids are complicated by the interplay of ionic (electrostatic) and covalent (shared-electron) bonding between the atoms, and by the pronounced influences of imperfections and different structural arrangements in crystals.

LUMINESCENCE MECHANISM

For lack of specific information about the energy levels in phosphors, two complementary types of simplified energy-level diagrams have been devised to give a generalized picture of the mechanism of luminescence. One such diagram, shown in Fig. 8, depicts the allowed potential energies of a *luminescence center* as a function of averaged interatomic spacing, $\bar{x}$, where $\bar{x}_0$ is the averaged spacing between the atoms

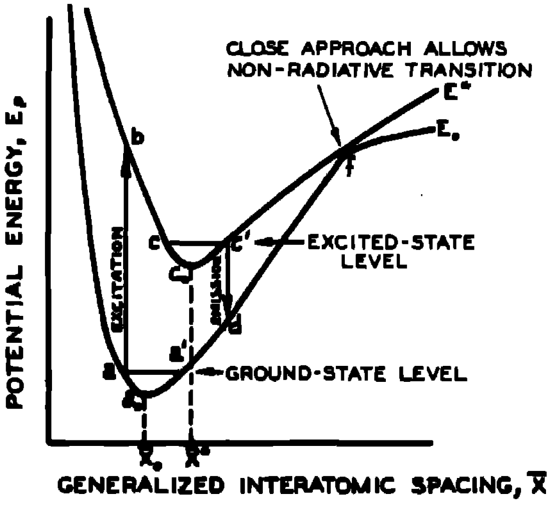


FIG. 8. Configuration-coordinate energy-level diagram of a phosphor impurity center, where the potential energy of the center is plotted as a function of the *average* distance between the atoms in the center.

of the unexcited center at equilibrium. At 0°K, the ground-state energy level would be very near a_0, corresponding to minimum potential energy and minimum atomic vibration. At room temperature, however, the system (center) has considerable vibrational energy, so the ground-state level lies higher, such as at a, where the amplitude of atomic vibration is proportional to a'-a (imagine the system passing through a_0 as it rolls from a to a' and back, in the potential well). When a bit of excitation energy of adequate magnitude, usually greater than 2 ev, is transmitted to the center, the energy of the center may be raised from a on the ground-state curve, E_0, to b on the excited-state curve, E^*. Within about 10^{-12} second after excitation, the atoms of the excited center readjust to a new equilibrium spacing, $\bar{x}^*$, and the energy difference b-c is given up as heat to the surrounding host crystal. With the center in the excited-state level c, the probability of a radiative transition from c' to d is determined by the natures of the impurity and host crystal, being practically independent of temperature, but the probability of a nonradiative transition to the ground state via $c' \rightarrow f \rightarrow a$ increases exponentially with temperature. Here, then, the observed phosphorescence for this luminescence without internal ionization is practically independent of the temperature when $kT << \Delta E$, or of the kind, duration, and intensity of excitation; and the decay proceeds according to

$$L = L_0 \epsilon^{-(\alpha + \nu_a \epsilon^{-\Delta E/kT})t}$$

where the atomic vibration frequency, ν_a, is about 10^{12} sec^{-1}, and the thermal activation energy, ΔE, is the energy difference $f - c_0$. The observed decrease of luminescence efficiency with increasing temperature may be visualized as a raising of level c so that an increasing proportion of excited states "spill over" via f without producing radiation. If, at any given temperature, the levels c and f practically coincide, then the center is a ***poison*** in that it is a means for rapidly degrading excitation energy into heat. This picture, then, illustrates how a center which produces luminescence at low temperatures may be a poison center at higher temperatures. The number of available efficient phosphors decreases rapidly with increasing operating temperature, with hardly any phosphors having useful efficiencies above 400° C. In general, phosphors should be operated at as low temperatures as possible, although some power-law-decay phosphors exhibit an intermediate optimum operating temperature where traps are efficiently emptied by thermal energy.

Another type of energy-level diagram, shown in Fig. 9, depicts the energy levels of a luminescence center as a function of distance along a row of atoms in the crystal. This type of diagram emphasizes the fact that the discrete energy levels of isolated atoms are spread out into bands in solids, the broadening being caused by interaction of the electrons of all the atoms in the crystal, because the Pauli exclusion principle allows only two electrons (of opposite spin) to occupy the same energy level in a given system. The diagram is drawn for a specific $\bar{x}$, so one must imagine that the spacings and potential barriers between the atoms change with every energy change of the center. According to the diagram, the impurity atom, I_O: (1) lowers the normal potential barriers between the host-crystal atoms in its vicinity, (2) introduces an additional occupied level, E_I, into the forbidden zone of host-crystal energies, and (3) introduces additional discrete unoccupied excited-state levels, $E^*_{I_n}$, whose extensions into the surrounding crystal increase as $E^*_{I_n}$ increases until, in the conduction band, E^*_C, an excited electron is free to move through the host crystal. The excitation transition $E_I \rightarrow E^{**}_{I_1}$ in Fig. 9 corresponds to $a \rightarrow b$ in Fig. 8, and the radiative return $E^*_{I_1} \rightarrow E^*_I$ corresponds to $c' \rightarrow d$. As drawn, this process is highly localized, and the spontaneous decay is exponential. When the low-lying, highly localized excited state, $E^*_{I_1}$, is absent, and the center is excited to higher levels wherein the excited electron may wander some distance away from its parent atom, then the electron may become trapped at a distant point, where it must be released by an additional activation energy before it can return to make a radiative transition from a low-lying $E^*_{I_n}$ level. When the excited electron travels through the conduction band, E_C, it may be trapped by a remote unexcited center, forming a new filled level (*e.g.*, E_{I^-}). This type of trapping is most probable when the impurity is a multivalent ion; for example, a Sm^{+++} impurity can trap an extra electron to become Sm^{++}. Regardless of whether the excited electron is trapped in a metastable state in its center of origin or in a remote center, the phosphorescence is strongly dependent on temperature and on the kind, duration, and intensity of excitation. The complex decay then proceeds by thermally activated release of trapped electrons according to

$$L = L_{0_1} \epsilon^{-\nu_{a_1} t \epsilon^{-\Delta E_1/kT}} + L_{0_2} \epsilon^{-\nu_{a_2} t \epsilon^{-\Delta E_2/kT}} \cdots + L_{0_N} \epsilon^{-\nu_{a_N} t \epsilon^{-\Delta E_N/kT}}$$

where the subscripts *1, 2, 3* · · · N denote traps of different densities and depths ΔE_1, ΔE_2, ΔE_3, . . . ΔE_N which make different contributions L_{O_1}, L_{O_2}, L_{O_3}, . . . , L_{O_N} to the luminescence output at time $t = 0$. This lengthy expression is usually shorthanded by the power-law-decay ***approximation*** $L = L_O t^{-n}$, since, as previously noted, *n* varies not only with the type of phosphor, but with the temperature, decay time, and conditions of operation. Both exponential and power-law decays can occur, without change in spectral distribution, by exciting a center such as the one generalized in Fig. 9 to $E_{I_1}^{**}$ and higher levels, as long as the final radiative transitions take place from $E_{I_1}^{*}$ to E_I^{*}. Almost all phosphors which exhibit initial exponential decays eventually trail off into power-law "tails" which bespeak the delayed returns of distant trapped electrons that make the same final radiative transition as do the highly localized untrapped excited electrons responsible for the predominant exponential decay. As is to be expected from Fig. 9, electronic conduction parallels the growth and decay of many power-law-decay phosphors, whereas little or no conduction is observed when the decay is predominantly exponential.

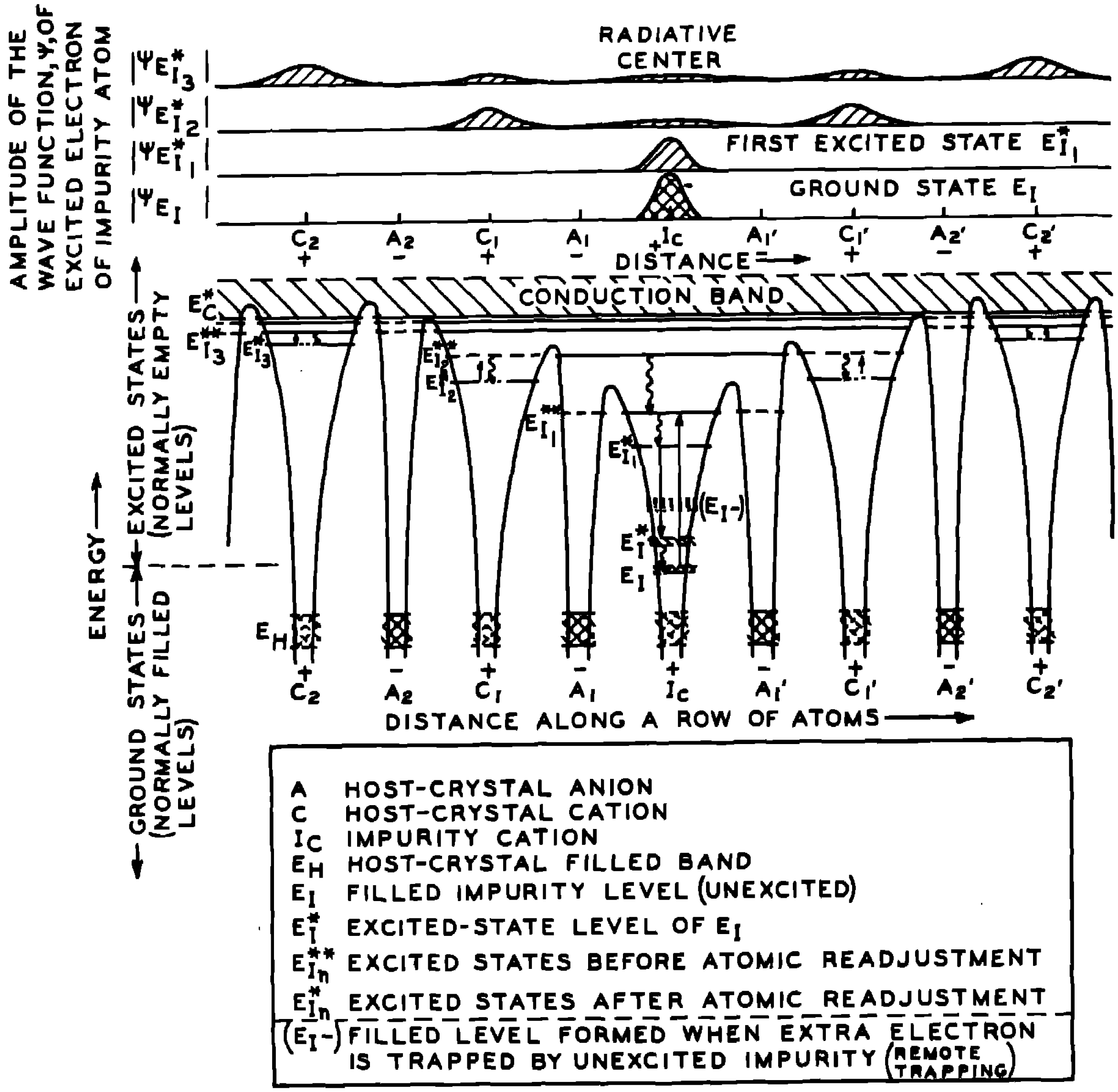

AMPLITUDE OF THE WAVE FUNCTION, Ψ, OF EXCITED ELECTRON OF IMPURITY ATOM
|ΨE*I3|
|ΨE*I2|
|ΨE*I1|
|ΨEI|
RADIATIVE CENTER
FIRST EXCITED STATE E*I1
GROUND STATE EI
C2 + A2 − C1 + A1 − +Ic A1′ C1′ + A2′ − C2′ +
DISTANCE
CONDUCTION BAND
E*C
E**I3
E*I3
E*I2
E**I2
E**I1
E*I1
(EI−)
E*I
EI
EH
+ C2 − A2 + C1 − A1 + Ic − A1′ + C1′ − A2′ + C2′
DISTANCE ALONG A ROW OF ATOMS
ENERGY
EXCITED STATES (NORMALLY EMPTY LEVELS)
GROUND STATES (NORMALLY FILLED LEVELS)
A HOST-CRYSTAL ANION
C HOST-CRYSTAL CATION
Ic IMPURITY CATION
EH HOST-CRYSTAL FILLED BAND
EI FILLED IMPURITY LEVEL (UNEXCITED)
E*I EXCITED-STATE LEVEL OF EI
E**In EXCITED STATES BEFORE ATOMIC READJUSTMENT
E*In EXCITED STATES AFTER ATOMIC READJUSTMENT
(EI−) FILLED LEVEL FORMED WHEN EXTRA ELECTRON IS TRAPPED BY UNEXCITED IMPURITY (REMOTE TRAPPING)

FIG. 9. Energy-level diagram of a row of atoms in a phosphor impurity center. The lower part of the figure shows the lowering of the potential barriers in the neighborhood of the impurity, and the relatively discrete occupied and excited-state energy levels introduced by the impurity. The upper part of the figure shows a plot of the absolute value of the wave function, ψ, of the optical electron responsible for luminescence (ψ^2 is a measure of the probability of finding the electron in a given location). The breadths of the excited-state levels increase with height and so the upper levels may overlap each other and the conduction band.

Stimulation of phosphorescence by low-energy (long-wavelength) photons, as in Fig. 3, is readily understood by picturing the weak photons as having just enough energy to raise trapped electrons out of their traps so they can make radiative recombinations with the parent ionized centers. Quenching of phosphorescence by higher-energy photons, however, apparently involves exciting the system to a high-energy level near or above *f* in Fig. 8, *i.e.*, the trapped excited electron is raised so high in energy that the surrounding atoms are set in violent agitation and the excitation energy is dissipated as heat.

LUMINESCENCE EMISSION SPECTRA

Both line and band emission spectra may be produced separately or simultaneously by phosphors. Line spectra are obtained when radiative transitions take place between discrete highly localized energy levels. Such discrete levels often occur when well-oxidized impurity ions with incomplete inner shells (*e.g.*, Eu^{+++} and Cr^{+++}) form luminescence centers. For example, $ThSiO_4$: Eu(1), crystallized at 1,250° C in oxygen, gives a line emission spectrum attributable to electrons with unpaired spins in the *inner*, well-shielded, incomplete 4f shell of Eu^{+++} making transitions between discrete subatomic levels having different resultant spin quantum numbers. When this phosphor is heated in a reducing atmosphere, however, the unpaired 4f-shell spins are apparently paired and a band emission is obtained in place of the previous line emission. The band emission is attributed to the *outer* valence electrons of Eu^{++} making transitions between levels having different principal and angular-momentum quantum numbers (where at least one of the levels is a band).

The chemical and structural constitutions of phosphors determine, of course, the locations and breadths of their emission lines and bands. Of about 10^5 different samples of artificial inorganic phosphors that have been synthesized here and abroad, the most useful phosphors have band widths of the order of 0.7 ev, although lines narrower than 10^{-3} ev and bands broader than 2ev have been obtained in some cases. Empirical methods for controlling the locations of emission bands in almost any part of the visible and near-visible spectrum have been developed for several efficient phosphor families where variations in host-crystal composition, in particular, afford excellent control over the properties of the resultant phosphors. For example, increasing partial substitution of cadmium for zinc (or selenium for sulphur) in any of the three zinc-sulphide phosphors shown in Fig. 7 gradually shifts the emission spectrum toward the infrared. At present, the white-emitting luminescent screens of direct-viewing television cathode-ray tubes are made of a mixture of blue-emitting hex.-ZnS : Ag(0.01) and complementary yellow-emitting hex.-1.3ZnS · CdS : Ag(0.01). (The latter phosphor is also useful for X-ray fluoroscope screens.) Similarly, luminescent screens for direct-viewing color television may be obtained by selecting appropriate blue-, green-, and red-emitting members of this phosphor family. In the case of the outstandingly useful phosphor family based on rbhdl.-Zn_2SiO_4 : Mn(1), increasing substitution of germanium for silicon produces a gradual shift of the emission band toward the red, but when beryllium is substituted in increasing proportions for the zinc, the original green emission band peaked at 5,250 Å decreases and a new orange-red emission band rises at 6,300 Å. The high activator proportions of silicate phosphors make them particularly useful for operation under conditions of intense excitation. For example, the three different luminescent screens for the three (trinoscope) cathode-ray tubes used in laboratory demonstrations of color television on a theatre scale may be made of blue-emitting rbhdl.-Zn_2SiO_4 : Ti(1), green-emitting rbhdl.-Zn_2SiO_4 : Mn(1), and red-emitting rbhdl.-$Zn_8BeSi_5O_{19}$: Mn(2). White-emitting luminescent screens for "fluorescent" lamps are made either by mixing blue-emitting monocl.-Mg_2WO_5 :[W] with yellow-emitting rbhdl.-$(Zn:Be)_2SiO_4$: Mn, or by using a cadmium(or calcium)-fluoro(chloro)-phosphate : Mn : Sb phosphor whose two different activators produce two complementary emission bands. It may be noted that the influence of new host-crystal atoms should depend not only on the nature of the new atom, but also on whether the new atom becomes an immediate neighbor or just a near neighbor of the emitting atom or center, and whether the luminescent center is founded on a substitutional or interstitial impurity.

LUMINESCENCE EFFICIENCY

When phosphors are excited by low-energy photons (*photoluminescence*), quantum efficiencies exceeding 90 percent have sometimes been obtained. For example, the phosphor coating of a green-emitting "fluorescent" lamp converts over 90 percent of the input 2,537-Å (4.9-ev) primary photons into emitted luminescence photons having an average energy of about 2.4 ev (5,250 Å). On an energy basis, this luminescence process is $(2.4/4.9)90 \approx 45$ percent efficient. In some cases, the energies of the primary and emitted photons lie even closer together, so that the energy efficiency may be higher. It is rare, however, that the energy efficiency of photoluminescence of phosphors exceeds about 80 percent, because there is always some gap between the peaks of their excitation and emission bands (*cf.* Fig. 7). For a given average energy of the emitted photons $h\bar{\nu}_{em}$, the energy efficiency, $\mathcal{E}$, decreases with increasing energy of the excitant photons, $h\bar{\nu}_{ex}$; i.e., $\mathcal{E} \propto \bar{\nu}_{em}/\bar{\nu}_{ex}$. This is true until $\bar{v}_{ea}$ becomes large enough to produce internal photoelectrons with sufficient energy to produce in turn more than one luminescence photon. When this happens, as it does for excitation by X-rays and gamma-rays (*roentgenoluminescence*), the luminescence process is essentially cathodoluminescence.

When phosphors are excited by fast charged material particles (*cathodoluminescence* and *ionoluminescence*), the energy efficiency is vanishingly small for low primary-particle energies because slow particles dissipate their energies in the inefficient (distorted and chemically different) surface layers of the phosphor crystals. It is only in rare cases that detectable luminescence output can be obtained from phosphors excited by 5-ev primary electrons, and even at primary energies of thousands of volts the energy efficiency does not exceed about 10 percent. The low efficiency which obtains even when the primary particles penetrate well into the efficient volumes of phosphor crystals is attributed to the large difference between the absorbed energy bits (approximately 25-ev average) and the emitted photons (approximately 2.5-ev) and to the difficulties of energy transfer from the predominant host-crystal absorber atoms to the fewer activator centers.

LUMINESCENCE OUTPUT

The radiances of phosphors *during* excitation by photons are limited mostly by the low intensities of available photon sources. With available sources of ultraviolet, for example, the maximum luminances of visible-light-emitting phosphor screens are of the order of 5,000 millilamberts (mL), or about 2×10^{16} photons emitted per square centimeter per second. On the other hand, brief instantaneous luminances exceeding 10^7 mL (over 10^{20} photons $\mathrm{cm}^{-2}\ \mathrm{sec}^{-1}$) can be obtained from phosphor screens struck by a well-focused, high-voltage, scanning cathode-ray beam, although the sustained averaged luminance of such a scanned screen generally may not exceed about 10^5 mL (4×10^{17} photons $\mathrm{cm}^{-2}\ \mathrm{sec}^{-1}$) without heating the screen above the temperature range in which appreciable luminescence efficiency is obtained. (It may be recalled that fresh snow in full sunlight has a painful luminance of about 10^4 mL.) In a conventional direct-viewing television cathode-ray tube, producing 50 to 100 mL in the image highlights, a given screen element the size of the cathode-ray-beam area is excited for about 1.5×10^{-7} second, 30 times a second, for a summed duration of only 16 seconds of actual operation time per 1,000 hours of total operation time. On this basis alone, it seems odd that the efficiency of the screen should change somewhat during 1,000 hours elapsed (16 seconds actual) time of operation. During the actual operation time, however, the instantaneous power input into a screen element is about 10,000 volts $\times\ 2 \times 10^{-4}$ ampere/0.001 $\mathrm{cm}^2 = 2000$ watts/cm^2. This power loading is almost ten times as high as the 250 watts/cm^2 absorbed power input (and radiated power output) of a tungsten filament in an ordinary incandescent lamp. In projection cathode-ray tubes, the power loadings may be several orders of magnitude higher than in direct-viewing cathode-ray tubes.

The radiances of phosphors *after* excitation are determined by their decay characteristics and light sums under the operating conditions. The ***light sum*** is the total radiance per unit area integrated over the entire afterglow interval. Integration of the decay curves of trap-type phosphors such as hex.-ZnS : Cu and cub.-Sr(S : Se) : $SrSO_4$: CaF_2 : Sm : Eu (taking into account the penetration of the primary particles) has shown that about 10^{18} potential photons/cm^3 may be stored in the excited volumes of some phosphor crystals under favorable conditions. This number is of the same order of magnitude as the number of Cu or Sm impurity centers in the cited phosphors, thus lending additional support to the idea that these impurities are the trapping agents. To a first approximation, the light sum is proportional to (1) the number of excitable centers and traps per unit volume, (2) the depth of penetration of the primary particles, and (3) the intensity and duration of the excitation (up to saturation).

The time interval in which the light sum is practically all released may be varied enormously by careful choice of phosphors and operating conditions. For example, (1) screens of hex.-ZnO : [Zn], cub.-MgS : Sb, and rhomb.-$BaSO_4$: Pb give up most of their stored luminescence energy in about 10^{-6} second in cathode-ray tubes used for flying-spot image pickup in television, (2) a cascade screen, wherein a cathodoluminescent blue-emitting hex.-ZnS : Ag phosphor excites a photoluminescent yellow-emitting hex.-9ZnS · CdS : Cu phosphor, emits about 0.03 mL 3 seconds after excitation in radar cathode-ray tubes, and has luminances which are detectable by the well-dark-adapted eye for many hours, and (3) screens of photoluminescent cub.-Sr(S : Se) : $SrSO_4$: CaF_2 : Sm : Eu retain most of their light sums for about six months at room temperature, thereby providing useful long-duration retentivity of information and infrared stimulability.

CONCLUDING REMARKS

Man-made phosphors, which were unimportant alchemical novelties during the 17th and 18th centuries, found their first important uses in the 19th century as visible indicators of certain invisible energetic particles, such as ultraviolet and x-ray photons, cathode rays, and alpha particles. In recent years of the 20th century, the *direct* conversion of the energies of these invisible particles into light, at operating temperatures near room temperature, has become a major commercial function of phosphors which are now produced at the rate of over 200,000 kilograms a year. Meanwhile, phosphors are finding increasing scientific use in detecting these invisible particles and others, including infrared and gamma-ray photons, fast-moving ions, and even neutrons, by converting their energies into radiations which the human eye may detect directly, or indirectly through other photosensitive devices, such as multiplier phototubes (usually coupled with oscilloscopes or meters), photographic films, or other phosphors used in cascade.

In addition to the practical progress already made by empirical phosphor research, some progress has been made toward developing a qualitative theory of luminescence of solids, although a useful quantitative theory is not yet available. Luminescence is such a convenient and sensitive indicator of changes of composition, structure, and atomic interactions in solids that it has contributed much to our improved understanding of the solid state of matter. In the future, the practical consequences of this broad aspect of luminescence research may well overshadow the tangible results already obtained.

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The Nature of the Organizer

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APPROXIMATELY TWENTY-FIVE YEARS AGO, Spemann and Hilde Mangold demonstrated that the dorsal lip of the blastopore acts as the primary organizer of the amphibian embryo after it is carried inside the gastrula to form a layer of chordamesoderm beneath the ectoderm. The contact thus established between these two layers results in an induction by the chordamesoderm (organizer) of nervous tissue in the overlying ectoderm. Since this discovery was made, an intensive search has been conducted for an explanation of both the stimulus and the response in this reaction. In terms of biochemistry and cellular physiology, however, the precise nature of embryonic induction still eludes us. It may be useful, nevertheless, to summarize the current ideas on the nature of the organizer.

First, let us consider the question of specificity of organizer action. Many studies have suggested that the inducing stimulus is nonspecific. It has been shown that amphibian ectoderm capable of response (competent) can be induced to form neural tissue by an array of inductors, some of which are: 1) living organizers from other vertebrate embryos; 2) extracts from whole embryos or parts of embryos; 3) tissues from the embryonic or adult bodies of many kinds of animals, providing the tissues are first killed by heat, drying, freezing, or treatment with organic solvents; 4) certain chemical compounds, such as cephalin, digitonin, and various polycyclic hydrocarbons; and 5) chemical or physical conditions that cytolyze some of the ectodermal cells with the release of toxic products evoking a neuralizing response in the surviving cells. Actually there may be no distinction between the last two categories.

Spemann (*11*) himself was finally inclined to the conclusion that the inducing stimulus is nonspecific and Holtfreter (*6*, p. 34) has recently taken this position, pointing out that neuralization of competent ectoderm "can be achieved by the application of various agents which have not more in common than the faculty of increasing the permeability of the cell membrane, and of causing cytolysis if applied in excess." If this interpretation is correct it follows that the factors for specificity of the reaction lie within the ectoderm.

On the other hand, there are studies which suggest that inductors are not qualitatively alike and that the specificity of induction does not reside entirely within the reacting system. Evidence supporting this interpretation includes the following points. 1) The results of experiments on regional determination indicate differences in the action of the organizer along the primary axis of the embryo. Thus, anteriormost mesoderm induces brain and sense organs, whereas more posterior levels induce spinal cord. 2) Dead inductors differ from living organizers in that the response to the former lacks the organization and completeness of anatomical pattern (individuation) which characterize the secondary embryo developing in response to a living organizer. Holtfreter (*8*, p. 33) refutes this point, however, as follows: explants of competent ectoderm stimulated by cytolyzing agents "differentiate not merely into a heap of neural cells, but the previously nonorganized cells become integrated into anatomical patterns which can be identified as brain diverticula. If these formations are covered by a mantle of epidermis the latter frequently forms nasal pits and frontal glands . . . . the original concept of the organizer as an all-powerful individuating agent should be revised. Furthermore, the data available leave little doubt that it is futile to make a distinction between living inductors and artificial 'evocators.'" Holtfreter admits, however, that "posterocephalic" inductions were not obtained by the action of cytolyzing agents and that, furthermore, mesodermal structures have never been observed in the explants. 3) Living inductors can evocate mesodermal structures; dead ones usually do not. Chuang (*5*), for example, observed the induction of muscle, notochord, pronephros, and other mesodermal structures by fresh mouse kidney. Induction of notochord and pronephros failed if the kidney had been boiled for five minutes and no mesodermal structures were obtained if it had been boiled for fifteen minutes. Moreover, boiling for varying periods changed the relative frequency with which the several ectodermal organs were formed. Holtfreter (*7*) had observed earlier that prolonged boiling of a tissue or heating to 135° C reduced the activity of the inductor, and a temperature of 172° completely abolished it. 4) It was observed by Waddington (*12*) that boiled nuclei were better inductors than boiled cytoplasm with respect to percentage of inductions obtained and volume of induced structures. Chuang found also that newt liver and mouse kidney were unlike in their inductive actions.

These examples are sufficient, I think, to indicate the type of evidence supporting the contention, on the one hand, that inductors are nonspecific and, on the other hand, that they are different in their action and that some measure of the specificity in response is a function of the stimulus. Unfortunately, as Needham (*9*) has so clearly stated, we have no adequate test for induction. A response by competent ectoderm is unsatisfactory because ectoderm itself may possess the inducing agent in a bound or masked form. Ventral ectoderm which cannot induce when living will stimulate neuralization if killed. We lack a reacting system which will respond to a neuralizing stimulus but which is incapable of acting as an inductor alive or dead.

We may proceed further in our analysis, however, if we assume that the critical agent in induction is the same irrespective of whether the stimulus comes from *without* the ectoderm or whether it is released *within* the ectoderm. According to the first concept (lefthand side of Fig. 1) a nonspecific stimulus produces a change in permeability of the inner membranes of the ectodermal cells which somehow sets off the chain of reactions leading to the formation of a neural tube. Maybe a bound substance (encircled x) is released, or perhaps it is synthesized and then, like a virus, is self-duplicated within the cells. In any event, free x is the critical inducing agent. According to the second concept (righthand side of Fig. 1), free x of specific qualities is provided by an inductor—in the living embryo by the mesoderm—which diffuses into the ectoderm and initiates neuralization. Release of bound x or its synthesis and self-duplication might follow secondarily. In both schemes x is the same. What is x?

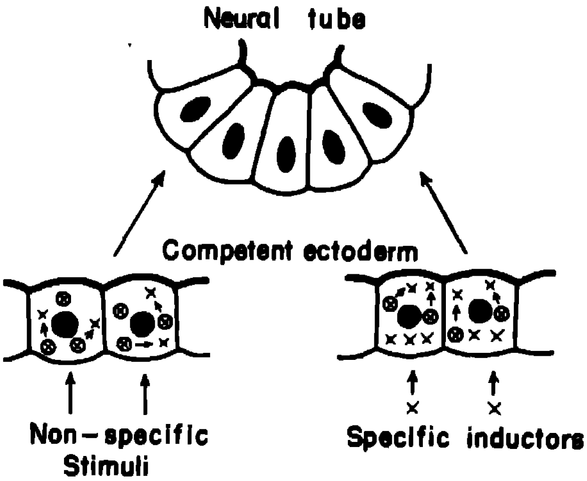

FIG. 1.

Two principal suggestions as to the chemical nature of the inducing agent have been proposed: Needham's sterol theory and Brachet's nucleoprotein theory. Needham (*9*) postulated that the cells of the dorsal lip possess the inducing steroid substance in a bound form—perhaps in a polysaccharide-protein-sterol complex. In the course of gastrulation the characteristic metabolism of the organizer breaks down the complex, releasing the sterol which induces the overlying ectoderm to form a neural tube. Evidence presented by Needham, Waddington, and their collaborators includes the following points. 1) The inducing activity of ethereal extracts of embryonic and adult tissues was traced to the digitonin precipitate of the unsaponifiable fraction. Later Barth (*2*) showed that the protein fraction exhibited a greater inducing power. 2) Pure sterols or sterol-like compounds acted as evocators of a neural response in competent ectoderm. 3) Lastly, the dosage of an active steroid required for induction was very low. In connection with the last point, the work of Shen is cited by Needham as being a strategic piece of evidence. Shen (*10*) recorded induction with a water-soluble carcinogenic hydrocarbon, dibenzanthracene, in very small concentrations. A maximal response of 41 percent induction of neural tube was obtained with a dose of .0125 γ per embryo. This dosage was much smaller than those of nonsteroid substances required to evoke a neural response and was in the same general range of concentration as that shown by other biologically active substances, such as hormones and vitamins.

Brachet, on the other hand, has extended the earlier suggestion of Barth that the organizer may be a protein, by his studies on the relation of ribonucleic acids to induction. According to Brachet (*4*) the inducing substance may be a nucleoprotein released from the mesoderm in the form of granules which probably include other substances, possibly enzymes. These granules are then engulfed by the ectoderm within which neuralization is initiated. Another possibility is that the metabolism of the mesoderm splits the nucleoprotein into mononucleotides, which become the activitating agents when transferred to the ectoderm. Very briefly, some of the evidence presented by Brachet for a relationship between induction and ribonucleic acid is as follows. 1) Grafts show a decrease in cytoplasmic basophilia in those instances in which they act as an inductor but not in the absence of a response by the ectoderm overlying the graft. Cytoplasmic basophilia is indicative of the presence of ribonucleic acid. 2) Ectoderm which becomes induced to form a neural tube exhibits increased cytoplasmic basophilia, but not if neuralization fails. 3) The inducing power of a variety of nucleoproteins, including plant and virus nucleoproteins, is proportional to their ribonucleic acid content. 4) Crushed eggs or tissues from the early embryo exhibit basophilic granules which after centrifugation are accumulated in the clear layer. This layer, when grafted in a coagulated state, is the only one which exhibits considerable inducing power. 5) Breakdown of the nucleoprotein by thermal or enzymatic methods abolishes its inducing power.

Brachet's suggestion thus far described is in terms of a specific inductor from outside the ectoderm. He points out, however, that ribonucleic acids may be involved in substance x, which is released within the ectodermal cell in response to some nonspecific cytolyzing agent. He has observed that in cytolysis there are changes in cytoplasmic basophilia, namely, a rise at first, followed by a decline—changes suggestive of synthesis and then release or breakdown of ribonucleic acids.

For further analysis of the problem of induction, certain lines of research on the metabolism of the embryo may be rewarding. The researches of Needham, Boell, Barth, Brachet and others (see Boell, *3*) are providing data on respiration, enzymatic activities, et cetera. One line of investigation may be especially useful, namely, a study of protein synthesis in the amphibian gastrula and neurula. Using radioactive tracers, Abrams, *et al.* (*1*) have shown recently that the amino acid glycine is a probable precursor of the purines adenine and guanine, the purines in nucleic acids. Friedberg and Eakin (*6*) have studied the uptake of radioactive glycine by the amphibian gastrula and neurula and have obtained evidence of a greater incorporation by the dorsal half of the embryo and probably by the dorsal lip than by ventral regions. Brachet had shown earlier that dorsal halves of gastrulae and neurulae contained more ribonucleic acid than the ventral halves. Such physiological investigations may eventually prove to be decisive in elucidating the chemical nature of the organizer.

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TECHNICAL PAPERS

Thermal Separation of Radiomercury From Radiosodium[1]

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A number of physiologic phenomena can be studied best by the simultaneous administration of two or more radioactive isotopes. If their half-lives differ sufficiently, no problems arise. In some instances it is feasible for the separation to be effected chemically, but such a procedure is beyond the realm of most clinical investigations. Physical methods employing counters capable of distinguishing beta from gamma radiation and high from low energy particles are often successful. A mass spectrometer may be used. This report is concerned with the description of a method which is practical for separating radioactive mercury[2] from radioactive sodium[3] (Na^{22}) and presumably from other elements with similar thermodynamic constants. The method utilizes the well-known intrinsic property of mercury— its volatility under conditions available in ordinary laboratories.

TABLE 1

VOLATILIZATION VALUES

Specimen	Tube	Mean ± S.D. (%) Before heat (cpm)	Mean ± S.D. (%) After heat (cpm)	Amount remaining (%)	$\frac{Na^{22}}{Na^{22} + Hg^{203-205}} \times 100$
$Hg^{203-205}$	A	3,918 ± 4.95	41.3 ± 35	1.05	
Na^{22}	A	2,193 ± 4.73	2,242 ± 3.79	102	
$Na^{22} + Hg^{203-205}$	A	5,620 ± 4.93	1,995 ± 6.43	35.4	35.8
$Hg^{203-205}$	B	7,881 ± 6.81	60 ± 36	0.77	
Na^{22}	B	3,788 ± 3.75	3,864 ± 3.95	102	
Na^{22} $Hg^{203-205}$	B	10,462 ± 5.63	3,400 ± 5.91	32.4	32.4

Mercury, one of the oldest of therapeutic agents, combines with other elements to form many compounds, usually organic, of definite biologic interest. Its organic combinations are characterized by instability. If they are decomposed and the consequent behavior of the Hg is used to advantage, it is possible to remove 99 percent or more of the Hg from a given compound under conditions which are quantitative and simple.

In the present studies the biologic relationship between a mercurial diuretic (Mercuhydrin[4]) and sodium chloride is under investigation. To study the pharmacodynamics of diuresis produced by a mercurial diuretic, it is desirable to use such a compound synthesized with radiomercury ($Hg^{203-205}$). Such a procedure is expensive and time-consuming. This isotope of mercury has a physical half-life of 51.5 days. Its "practical" half-life was found to vary considerably, depending on environmental and chemical conditions, making quantitative, separatory studies of isotope activity extremely difficult. The present experiment was prompted by this discovery.

Thirty samples of an aqueous radioactive Mercuhydrin preparation were accurately measured onto filter paper discs and allowed to dry at room temperature. Similarly, 30 such samples of a solution of radioactive sodium (Na^{22}) chloride were prepared, to which, after drying, was added a known amount of radioactive Mercuhydrin solution. The papers were fixed to tinned discs with rubber paper cement. The three series of preparations were counted by separate, thin mica window Geiger-Müller counters with different sensitivities (Table 1).

After being counted, all preparations were placed alternately in position on a sheet of aluminum measuring 18″ × 12″ × $\frac{1}{16}$″ and heated in an oven to 250° C for one hour and twenty minutes. Upon removal and cooling they were again counted (Table 1). Interference by the rubber cement was shown to be nonexistent.

A mean of more than 99 percent of the mercury of a Mercuhydrin preparation was driven off by heat, whereas under identical conditions a sodium preparation did not change significantly. Naturally, stable mercurial salts or compounds would have to be rendered labile to heat to take advantage of vapor tension and boiling point differences. Further studies of a chemicophysical nature are in progress.

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[1] Aided by a grant from the Life Insurance Medical Research Fund, the War Contract No. W-49-007-Md-389, the Hells Institute for Medical Research, and the Mrs. E. J. Caire Fund for Research in Heart Disease.

[2] Preparation item No. 47B, $Hg^{203-205}$, U. S. Atomic Energy Commission, Oak Ridge Laboratories.

[3] Secured through the courtesy of M. A. Tuve and Dean Cowie, Carnegie Institution of Washington, Department of Terrestrial Magnetism.

[4] Produced by Harold Krahnke, Edwin Sprengeler, and Darwin Kaestner, through the cooperation of Dr. H. L. Daiell of the Lakeside Laboratories, Milwaukee.

Apricots and Plums as Hosts of Western X-Disease[1]

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Stoddard (*3*) reported that peach, *Prunus persica* Batch., nectarine, *P. persica* var. *nucipersica* Schneid., and chokecherry, *P. virginiana* L., are natural carriers of the X-disease in eastern United States. He was able to transmit the disease by budding to the sand cherry, *P. besseyi* Bailey, Chinese bush cherry, *P. japonica* Thung., wild goose plum, *P. hortulana* Bailey, and almond, *P. communis* Arcang. He considered the wild black cherry, *P. serotina* Ehrh., and the beach plum, *P. maritima* Marsh, immune and reported no evident symptoms following inoculation into wild plum, *P. americana* Marsh. Palmiter and Parker (*2*) found diseased sour cherries, *P. cerasus* L., close to peaches and chokecherries affected with X-disease. They reported that "inoculations from affected sour cherries to peach resulted in typical peach-disease symptoms." Bodine (*1*) reported an estimated 100 peach trees infected with "western X virus disease" in western Colorado in 1944, and that no chokecherries were found in the immediate vicinity of the peach growing section. His survey of the nearest area where chokecherries were found revealed only healthy plants.

TABLE 1

RESULTS OF INOCULATION OF ELBERTA PEACH TREES WITH BUDS FROM PREVIOUSLY INOCULATED APRICOT AND PLUM TREES

Source of inoculum	No. of peach trees inoculated	Healthy	Diseased	
Apricots				
Jones	4	1	3	
Early Horn (1)	5	1	4	
Early Horn (2)	5	4	1	
Reece (local seedling variety)	4	4	0	
Plums				
Big Mack (1)	5	3	2	
Big Mack (2)	5	0	4	(1 winter killed)
Duarte-Satsuma hybrid (1)	5	3	2	
Duarte-Satsuma hybrid (2)	5	2	3	
Climax	5	4	0	(1 winter killed)
Red Late Hardy	4	4	0	
Omaha	5	5	0	
Hungarian prune	5	5	0	

Since X-disease is still present and spreading in Colorado peach trees and the situation remains unchanged as to the proximity of chokecherry trees to the peach area, other possible hosts of the X-disease were thought to exist. To test this hypothesis, buds were taken in the summer of 1946 from peach trees having the western X-disease and placed into nursery trees of several varieties of apricots growing on apricot seedling root stock and also into plums growing on peach root stock. In 1947, buds were taken from these 1946–inoculated trees and placed into small Elberta peach trees. Western X-disease symptoms expressed in the peach in 1948 showed that two varieties of each of the inoculated apricot and plum were carrying the western X-disease virus and none of the 40 uninoculated check trees was affected.

The results in Table 1 show that the Jones and Early Horn varieties of apricot and the Big Mack and Duarte-Satsuma plum can carry the western X-disease virus. All previously inoculated apricot and plum trees were reinoculated from peach in 1947 and the Climax plum now shows a premature yellowing and bronzing of leaves which suggest its possible infection. Inoculations from this tree, as well as other trees from which transmission was not obtained in 1947, were again made on Elberta peach in 1948. Symptoms found in other hosts require further study and will be reported later.

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Aureomycin, a New Antibiotic[1]

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A new antibiotic principle active against certain viruses and rickettsia (*6*) and against both Gram-positive and Gram-negative microorganisms (*1, 2, 5*) has been isolated from the substrate of *Streptomyces aureofaciens* (*4*). The antibiotic has been named aureomycin from the yellow color of the parent actinomycete and the golden color of the crystalline antibiotic.

Aureomycin is a weakly basic compound which contains both nitrogen and nonionic chlorine. Aureomycin when treated with alcoholic ferric chloride gives a greenish-brown color by reflected light and reddish color by transmitted light. The crystalline free base has the following properties: m.p., 168–169° C (uncorr.); $[\alpha]_D^{23°}$, -275.0 (methanol); solubility in water, 0.5–0.6 mg/ml at 25° C; very soluble in the Cellosolves, dioxane, and Carbitol; slightly soluble in methanol, ethanol, butanol, acetone, ethyl acetate, and benzene; insoluble in ether and petroleum ether; very soluble in aqueous solution above pH

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[1] This work was initiated and directed by the late Dr. Y. SubbaRow, and by Dr. J. H. Williams.

8.5; analysis: C, 54.56; H, 5.34; N, 5.77; Cl, 7.16; O, 21.17 (by diff.); mol. wt., 508 (*3*).

Aureomycin forms a hydrochloride with these properties: decomposes above 210° C; $[\alpha]_D^{23°}$, – 240.0 (water); approx. solubility in water, 14 mg/ml at 25° C; pH of aqueous solution, 2.8–2.9; analysis: C, 51.84; H, 5.24; N, 5.46; total Cl, 13.27; ionic Cl, 6.69; O, 24.19 (by diff.). The rhomboid crystals have a refractive index of 1.700 ± 0.005. The acute angle is 80 ± 5°.[3]

In 0.1 N hydrochloric acid, aureomycin shows absorption maxima at 230, 262.5, and 367.5 mμ. In 0.1 N sodium hydroxide the maxima are at 255, 285, and 345 mμ.

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2-Acetylamino-9-C^{14}-Fluorene[1]

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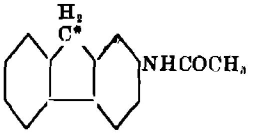
Since it was demonstrated by Wilson, DeEds and Cox (*4*) that 2-acetylaminofluorene causes a wide variety of cancer in rats, this compound has become of increasing importance in experimental cancer research (*1–4*). Present chemical methods are successful in accounting for only about one-third of the substance administered (*3*). With the hope of completely elucidating the mode of action of 2-acetylaminofluorene we have synthesized it with radioactive carbon-14 in the 9-position in the molecule.



Measurements were made with a Geiger tube having a window 4–5 mg/cm² and at a distance of 1½″.

The following equations give the yields and number of counts per minute at each step for a 22 mg/cm² sample from 2 mc of $BaC^{14}O_3$ and 11.5 gm of 2-iodobiphenyl.

$$\text{2-iodobiphenyl} \xrightarrow{87\%} \text{2-biphenylmagnesium iodide} \xrightarrow[\mathrm{C^{14}O_2}]{90\%}$$

$$\overset{\text{20,897 cpm}}{\text{2-}C^{14}\text{-biphenylcarboxylic acid}} \xrightarrow{88\%} \overset{\text{24,872 cpm}}{\text{9-}C^{14}\text{-fluorenone}} \xrightarrow{70\%}$$

$$\overset{\text{23,680 cpm}}{\text{9-}C^{14}\text{-fluorene}} \xrightarrow{79\%} \overset{\text{20,969 cpm}}{\text{2-nitro-9-}C^{14}\text{-fluorene}} \xrightarrow{90\%}$$

$$\overset{\text{24,832 cpm}}{\text{2-amino-9-}C^{14}\text{-fluorene}} \xrightarrow{84\%} \overset{\text{21,341 cpm}}{\text{2-acetylamino-9-}C^{14}\text{-fluorene}}$$

The metabolism of the radioactive compound is being studied by H. P. Morris, of the National Cancer Institute, and the results will be reported in a subsequent publication.

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Experiments in Crossing *Aedes* (*Stegomyia*) *aegypti* Linnaeus and *Aedes* (*Stegomyia*) *albopictus* Skuse[1]

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In 1937, Toumanoff (*4*) reported a series of crosses made between the two species of mosquitoes, *Aedes aegypti* and *Aedes albopictus*. In two trials he had two successful crosses of albopictus females and aegypti males. The offspring resembled albopictus. The F_2, F_3, and F_4 generations from these crosses also resembled albopictus. In four trials with aegypti females and albopictus males he had only one success, the offspring and F_2 generation resembling aegypti. Later (*5*) he reported five more crosses of albopictus females and aegypti males, two of which were successful, the F_1 again resembling the female parent. Hoang-Tich-Try (*2*) also reported four attempts at crossing albopictus females and aegypti males; two of the trials were successful, the F_1 resembling albopictus. He did not succeed in getting an F_2 generation. Edwards (*1*) comments on this work, suggesting the desirability of more detailed morphological studies of the crosses.

In 1944, Johannes Bauer tried to confirm this work, using colonies of *A. aegypti* and *A. albopictus* which had been maintained in the New York Laboratories of the International Health Division of The Rockefeller Foundation for several years. The origin of these colonies is not known. It was considered possible that, in the course of innumerable transfers of eggs and larvae, some mixing of the two species might well have occurred from time to time. Evidence of this was obtained, for upon examination of a large number of specimens from the cage of either colony, an occasional member of the other species would be found. Consequently, it can be suggested that neither of the lines was necessarily "pure." After preliminary trials, Dr. Bauer turned the project over to the

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[3] We wish to thank E. F. Williams, of the Stamford Laboratories, American Cyanamid Company, for the crystal analysis, and L. M. Brancone and staff for the microanalyses.

[1] Work conducted under the auspices of U. S. Naval Medical Research Unit No. 2 in the Laboratories of the International Health Division of The Rockefeller Foundation, New York. The Navy Department does not necessarily endorse the views set forth in this paper.

[2] The authors were formerly with NAMRU No. 2.

present authors. Unfortunately, in the limited time between changes in military assignments, only the brief observations below could be made.

Tests were carried out in an insectary with an average temperature of 75° F. The mosquitoes were placed in cages with two layers of screening ¼" apart, with the front opening covered by heavy muslin cloth. Sugar water was kept in the cages, and every third day a chick was introduced into each cage to provide a blood meal. Eggs were placed in containers in screened cages for hatching and the rearing of larvae. Each pupa was removed and put into a separate test tube, and each adult transferred to a separate dry tube as it emerged. The males and females to be introduced into cages were routinely checked under a low-power microscope by two observers.

TABLE 1

CROSSING ATTEMPTS WITH *A. albopictus* AND *A. aegypti* MOSQUITOES

Caged	Progeny	Observations
Trial A, female A. albopictus and male A. aegypti		
Group 1		
13 ♀ × 7 ♂	None	A few eggs, none hatched
Group 2		
59 ♀ × 37 ♂	None	Some eggs, none hatched
Group 3		
170 ♀ × 112 ♂	None	A few eggs, none hatched
Group 4		
59 ♀ × 123 ♂	None	No eggs
Trial B, female A. aegypti and male A. albopictus		
Group 1		
8 ♀ × 10 ♂	54 ♀ and 104 ♂	
F_2 generation		
44 F_1 ♀ × 83 F_1 ♂	11 ♀ and 31 ♂	
Group 2		
52 ♀ × 28 ♂	None	Numerous eggs, none hatched
Group 3		
105 ♀ × 42 ♂	2 ♂	Experiment interrupted
Group 4		
61 ♀ × 162 ♂	14 ♀ and 45 ♂	

A binocular dissecting microscope was used to check distinguishing markings of the offspring of the crosses. The pattern on the mesonotum, the sides of the thorax, the legs, the abdomen, the head, and the palpi was carefully examined. *A. aegypti* has a characteristic lyre pattern and *A. albopictus* a broad central band on the mesonotum. These are the principal distinguishing marks. The patterns of silver scales on the occiput and on the sternopleura and mesepimeron are also different. Comb-scale characters of the larvae were checked. Male terminalia were dissected out and examined. Particular attention was paid to the morphology of the ninth tergite, which is markedly different in the two species.

Experiments were started on August 5, 1944, and terminated on October 17, 1944.

The experiments are summarized in Table 1. The *albopictus* females of trial A did not feed readily on blood, while the *A. aegypti* females in trial B took blood readily. Sperm was found in the spermatheca of only one of 24 albopictus females (trial A, group 3) dissected, although copulation had been observed. In group 2 of trial B, copulation was observed and of three aegypti females examined on October 17, one had sperm in the spermatheca, although no eggs were hatched. All of several aegypti females from group 4 of trial B, examined on October 12, had sperm in their spermathecae.

All of the offspring, including the F_2 generation of group 1, trial B, resembled *A. aegypti* in every detail. The first adult F_2 were observed on October 17, but the experiment had to be terminated at that time.

It is noteworthy that in the experiments of Toumanoff and of Hoang-Tich-Try, as well as in our own tests, offspring of the crosses have resembled the female parent. In our work reported above, this resemblance held true down to the finest morphological details of larvae and adult mosquitoes which it was possible for us to check.

It is difficult to explain these results on a genetic basis. One possibility is that fertilization by the male of the other species was not a true fertilization, but served to stimulate parthenogenetic development of the ovum. Be this as it may, both male and female offspring were obtained.

It is interesting that Summers Connal (*3*) working on variations observed in *A. aegypti* in Lagos, Nigeria, has noted an extensive range of color variations (the lyre pattern remaining constant). The possibility that *A. aegypti* will cross with closely related species in nature is suggested.

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Effectiveness of Vitamin P Compounds in Counteracting Anticoagulant Action of Dicoumarol

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Campbell (*4*) and Overman, *et al.* (*8*) demonstrated in the rabbit that 2-methyl-1, 4-naphthoquinone counteracted the action of dicoumarol. Overman, *et al.* (*8*) also reported the ability of ascorbic acid to reduce the hypoprothrombinemic response to dicoumarol. Later, this Wisconsin group (*1*) found that dicoumarol increases the excretion of ascorbic acid in the rat.

TABLE 1

PROTHROMBIN TIMES IN RATS UNDER DICOUMAROL TREATMENTS*

	D	D M	D H	D H M	D R	D R M	C D	D C M	D C	D C AA
1.	9'	6'44"	9'33"	12'38"						
2.	15'15"	7'1"	14'51"	10'24"						
3.	10'46"	5'22"	4'35"	13'2"						
4.	11'51"	8'22"			5'38"	8'16"				
5.	14'3"	5'42"			7'38"	3'21"				
6.	12'38"	6'40"			9'21"	7'31"				
7.	11'16"	6'16"					5'21"	4'41"		
8.	5'4"						4'2"		2'26"	47"

* Abbreviations used are: D—dicoumarol; M—menadione; H—hesperidin; R—rutin; C—catechin; AA—ascorbic acid.

Since vitamin P compounds have been recommended as adjuncts in the clinical use of dicoumarol (*5*), it seemed important to determine any possible interaction between the two. Rats (250–300 gm in weight) were used in accordance with the technique of Overman, *et al.* (*7*). The chemicals under test mixed in cottonseed oil were administered orally on three successive days with the prothrombin time being determined 4 hours after the last dose. Five rats were in each series; dosages were as follows: dicoumarol, 40 mg/kg; vitamin P compound, 80 mg/kg; ascorbic acid, 80 mg/kg; Menadione, 3.2 mg/kg. Results are recorded as average values for each series. Prothrombin times were determined by the method of Campbell, *et al.* (*3*). From these findings, it is apparent that D-catechin and rutin counteract dicoumarol while hesperidin does not. Ascorbic acid counteracts dicoumarol and acts synergistically with D-catechin in this respect.

Thus, the synergism of ascorbic acid and the vitamin P compounds is found in at least three systems: (1) antihyaluronidase action (*2*); (2) antioxidant action for autoxidation of adrenaline (*9*); (3) counteraction of hypoprothrombenemia produced by dicoumarol.

The significance of the physiological antagonism of dicoumarol and vitamin P compounds is unknown; however, a similar antagonism in bacteriological systems has been reported (*6*). It seems logical that the mechanism controlling hemorrhage in all its phases would be interrelated. One of these mechanisms would be reflected in prothrombin times.

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Effect of *p*-Chlorophenoxyacetic Acid on the Vitamin C Content of Snap Beans Following Harvest

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Attention is being directed toward the effect of plant growth regulating substances on chemical changes that occur in fruits, leaves, and storage organs of plants after they are harvested. Some results of this research have been reported (*2*, *4*, *6*).

The vitamin C content of snap bean fruits (pods) increases as they develop, reaches a maximum as they attain full size, then decreases, regardless of whether the pods are harvested at this stage of development or left on the plant to mature (*1*, *5*).

In extending research in this field, experiments were made to determine the effect of *p*-chlorophenoxyacetic acid on the vitamin C content of bean fruits of marketable size. Bean plants (Black Valentine, Asgrow strain) were grown in a greenhouse. When the largest fruits first attained a size acceptable for commercial use, water mixtures containing various amounts of *p*-chlorophenoxyacetic acid and 1% of Tween 20[1] were sprayed on the attached fruits. Concentrations of the acid used were: 0, 50, 250, 500, and 1,000 ppm.

Samples for vitamin analysis consisted of 6 to 10 replicates of 50 gm each, and values reported are the averages of these replicates. All results are reported on the basis of fresh weight at the time of analysis. The vitamin C was extracted by the method of Loeffler and Ponting (*3*) and determined in a photoelectric colorimeter. Compensation for turbidity was applied when necessary. Tests with *p*-chlorophenoxyacetic acid and Tween 20 in water showed that the acid and detergent did not influence the vitamin C determinations.

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[1] A sorbitol derivative used as a solubilizer and supplied by the Atlas Powder Company of Wilmington, Delaware.

Four days after treatment the fruits were still in a good marketable condition. There was no statistically significant difference between the vitamin C content of untreated fruits and those sprayed with various amounts of the growth regulator.

TABLE 1

EFFECT OF PREHARVEST TREATMENTS WITH *p*-CHLOROPHENOXYACETIC ACID (400 ppm) ON THE VITAMIN C CONTENT OF SNAP BEAN PODS DURING STORAGE PERIODS IMMEDIATELY FOLLOWING HARVEST

Storage period (days)	Av. vitamin C content (mg/100 gm of tissue)		Percent decrease in vitamin C content		Percent moisture	
	Untreated	Treated	Untreated	Treated	Untreated	Treated
*Greenhouse—treated July 8, harvested July 12, 1948**						
0	17.6	22.2	. . .	. . .	87.8	90.3
1	13.5	21.8	23.3	1.8	88.8	90.5
2	11.7	20.6	33.5	7.2	87.6	89.5
3	11.2	22.0	36.4	0.9	88.1	88.6
4	11.0	19.6	37.5	11.7	87.5	89.9
Greenhouse—treated July 15, harvested July 19†						
0	23.4	24.0	. . .	. . .	86.7	90.5
1	17.8	21.8	23.9	9.2	86.9	87.4
2	16.9	21.1	27.8	12.1	84.7	87.9
3	15.4	19.1	34.2	20.4	86.0	86.9
4	13.6	19.7	41.9	17.9	85.8	85.2
Field—treated August 5, harvested August 9‡						
0	26.1	25.2	. . .	. . .	91.0	91.7
1	22.6	24.6	13.4	2.4	90.5	90.9
2	19.7	23.7	24.5	6.0	89.2	90.1
3	16.7	22.7	36.0	9.9	88.3	88.1
4	17.8	24.3	31.8	3.6	85.6	89.1
7	15.6	27.2	40.2	+ 7.4	84.1	82.9
9	12.6	22.2	51.7	11.9	81.9	83.7

* Difference required for significance: 5% level, 1.2 mg; 1% level, 1.6 mg.

† Difference required for significance: 5% level, 1.32 mg; 1% level, 1.75 mg.

‡ Difference required for significance: 5% level, 2.03 mg; 1% level, 2.68 mg.

Additional experiments were made to determine the effect of *p*-chlorophenoxyacetic acid on the vitamin C content of fruits of snap beans during a storage period beginning immediately after they were harvested. When about a third of the fruits on snap bean plants grown in a greenhouse had reached marketable size, they were sprayed with a water mixture containing 400 ppm of *p*-chlorophenoxyacetic acid and 1% of Tween 20. Untreated plants served as controls. After 4 days all those of a marketable size were harvested and spread out separately in a layer (1 to 2 fruits thick) in a room where the temperature varied between 74° and 76° F.

The vitamin C content of the untreated fruits decreased by 37.5% during the 4 days immediately following harvest (Table 1). In contrast, that of treated ones decreased by only 11.7%. At the end of the storage period, treated fruits contained 78% more vitamin C/100 gms of tissue than did the untreated ones, a highly significant difference.

The above greenhouse experiment was repeated. During storage, the vitamin C content of untreated fruits decreased by about 42% during the 4-day period, while that of treated ones decreased only 18% during the same period of time, a highly significant difference (Table 1). At the end of the storage period the treated fruits contained approximately 45% more vitamin C than did the untreated ones.

In another experiment, snap beans were planted under field conditions during the latter part of June 1948. By the first week of August the plants had developed a full crop of fruit, most of which had just reached marketable size. A water mixture containing 400 ppm of *p*-chlorophenoxyactic acid and 1% of Tween 20 was sprayed on the fruits. There were 12 rows of plants in the field. Each row was divided equally, and alternate ends were treated or left untreated.

Four days after treatment all fruits were harvested and handled as previously described. The vitamin C content of untreated ones decreased 31.8% during the first 4 days' storage, that of treated ones only 3.6%, a highly significant difference. After 9 days of storage, the treated fruit contained 76% more vitamin C than did untreated ones.

In both greenhouse and field experiments it was observed that the mixtures of *p*-chlorophenoxyacetic acid checked the growth of fruits that were partially developed at the time of treatment. There was no apparent effect on the size or yield of fruits sprayed when they had attained a size commonly used in the marketing of snap beans.

From this work it is evident that the use of a water mixture of *p*-chlorophenoxyacetic acid and Tween 20 resulted in the maintenance of a relatively high vitamin C content in bean pods following harvest. Further field tests are necessary to determine if this effect is of practical value.

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A Quantitative Hardness Tester for Food Products[1]

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A pressure-hardness tester has been designed by the writer and fabricated by machinists of the Division of Industrial Research to supply a quantitative method for testing hardness of fruits and other food products, replacing the qualitative "thumbnail" or "finger pressure" method. At present the device (Fig. 1) is being used to test hardness of pears in conjunction with a research project jointly sponsored by the Northwest Canners Association, Washington State Soft Fruit Commission and the Division of Horticulture, State College of Washington.

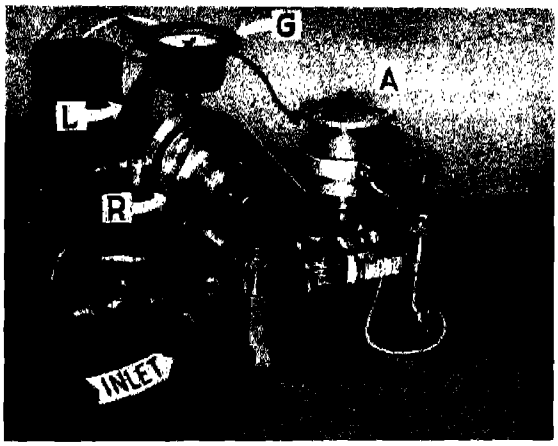

FIG. 1. Photograph of a quantitative hardness tester. Small tank not necessary when tester is connected to external source of gas pressure. Corresponding parts lettered as in Fig. 2.

The principle of the tester is the determination of that gas pressure necessary to force the blunt end of a piston a very small but fixed distance into the test material.[2] The tester now in use forces a rounded brass tip 5/32" in diameter 1/32" into the pear. The top plate serves both as a stop, restricting penetration to 1/32", and as an electrical contact, completing a circuit which lights an indicator lamp when maximum penetration is reached. Pressures found necessary to effect this penetration into normal green pears have been observed to vary from 50 to 65 pounds per square inch. Abnormally hard pears were found to test above 65. Tips of others sizes and penetrations of different depths may be used for other food products. Any convenient and suitable gas source may be used, such as compressed air or nitrogen.

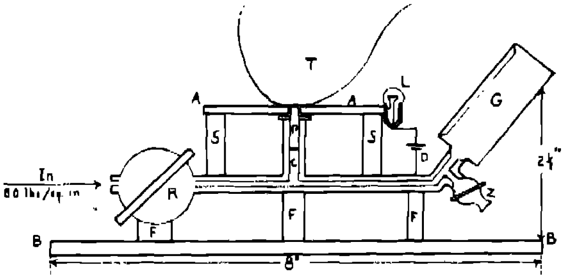

FIG. 2. Sketch of device shown in photograph. A—top plate; B—base plate; C—cylinder; D—dry cell battery; F—metal frame; G—pressure gauge; L—indicator lamp; P—piston; R—regulator valve; S—insulated support; T—test fruit; Z—release petcock.

Fig. 2 shows a simplified sketch of the tester, illustrating its basic operating principles. Future models will be constructed from this design.

No injury to the fruit is apparent or expected from this test. Pears are held firmly against top plate during the test, a barely visible indention being the only effect.

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[1] Published as Scientific Paper No. 811, College of Agriculture and Agricultural Experiment Station, Institute of Agricultural Sciences, State College of Washington, Pullman, Washington.

[2] A tester utilizing mechanical pressure from a spring was also designed and may be fabricated for later work. The writer is grateful to Prof. N. S. Golding for supplying a metal hypodermic cylinder body and piston and for suggestions concerning its use.

The Properties of the Enzyme-Substrate Compounds of Horse-Radish and Lacto-Peroxidase[1]

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Peroxidases are iron-containing enzymes which, on the basis of both spectroscopic and magnetic susceptibility data, form definite chemical compounds with their substrate, hydrogen peroxide. These enzyme-substrate compounds cause the very rapid oxidation of oxidizable substances (acceptors) such as ascorbic acid, pyrogallol, etc. One type of peroxidase is widely distributed in plants and is usually prepared from horse-radish root (horse-radish peroxidase). Another type is found in milk and is called lactoperoxidase. The pioneer work of Keilin and Mann (*10*) on horse-radish peroxidase and Theorell's (*16*) purification and extensive studies of both horse-radish and lactoperoxidase now make it possible to study in detail the properties of the several compounds which these enzymes form with hydrogen peroxide and the mechanism by which these compounds oxidize acceptors.

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[1] The horse-radish peroxidase, lactoperoxidase, and cytochrome C preparations used in these studies were generously supplied by Hugo Theorell and K. G. Paul. Many thanks are due to H. Theorell, D. Keilin, and E. F. Hartree for their criticism and advice in these researches. A special acknowledgment is made to the memory of Glenn Millikan, who greatly stimulated this development of the rapid-flow method for studies of enzyme-substrate compounds.

[2] John Simon Guggenheim Memorial Fellow 1946–1948; present address: Johnson Research Foundation, University of Pennsylvania, Philadelphia 4, Pennsylvania.

Theories (*12*) dating from 1913 have postulated that enzyme reactions involve enzyme-substrate compounds, and now these studies (*4*) give direct records of their reactions. Direct evidence of these chemical compounds of enzyme and substrate clearly shows that short-range, not long-range, forces are required for the action of these enzymes. The possibility that the long-range forces postulated by Rothen (*14*) play any part in these enzymatic reactions is very remote.

When the iron atom of horse-radish peroxidase combines with hydrogen peroxide, three distinct colored compounds are formed: green (I) (*18*), pale red (II) (*10*), and bright red (III) (*10*). All of them rapidly disappear when an oxidizable substance like ascorbic acid is added, with the result that the free enzyme and oxidized acceptor are obtained. Here studies have been made to show which of these three enzyme-substrate compounds are involved in the enzymatic activity of peroxidases and how the active complex reacts with the acceptor molecule.

These color changes are so rapid that a special method is needed, not only to measure the rates of formation and disappearance of the compounds, but also to obtain their absorption spectra. Various improvements (*5*) of the flow method of Hartridge and Roughton (*9*) and Millikan (*15*) now permit studies of the reaction kinetics and the absorption spectrum of an unstable enzyme-substrate complex that has a half-life of only several milliseconds and a molar concentration as small as 1×10^{-6}.

The spectra of the primary and secondary enzyme-substrate complexes. There are two striking features of the combination of these enzymes with their substrates; first, the brown enzyme solution becomes green, and secondly, this change appears to occur instantaneously. Theorell (*18*) first saw this reaction occur upon the addition of hydrogen peroxide to horse-radish peroxidase, and in these researches a similar lactoperoxidase-hydrogen peroxide complex has been found. In addition, a green primary hydrogen peroxide complex of the related enzyme, catalase, has been found (*6*). These three enzymes can also combine with substituted peroxides (methyl [CH_3OOH] or ethyl [C_2H_5OOH] hydrogen peroxide), and here again green primary complexes are found. In all nine cases studied, enzyme and substrate were found to combine in very rapid reactions.

By using the rapid flow apparatus, quantitative data on the absorption spectra of these green primary compounds have been obtained. The addition of peroxide to these enzymes causes a very large decrease in the intensity of their major absorption band as shown by the shift from curve A to curve I of Fig. 1. The spectra of the nine primary compounds studied are very similar, and it is concluded that they all involve the same type of iron-peroxide bond. From Theorell's studies of the magnetic susceptibility of related peroxidase compounds (peroxidase fluoride) (*17*), it is probable that the iron atoms of these primary enzyme-substrate compounds are bound by essentially ionic bonds in the primary complexes.

In peroxidases, these primary peroxide complexes rapidly shift into a red secondary form in about 0.1 sec under these conditions. These red forms were first seen and their visible absorption bands were measured by Keilin and Mann (*10*) using horse-radish peroxidase and by Theorell and Akeson (*19*) using lactoperoxidase. Curve II of Fig. 1 shows that the absorption band of the secondary complex differs considerably from that of the primary complex. Curve II closely resembles the absorption band of horse-radish peroxidase-cyanide which has been found by Theorell to have covalent bonding. Thus it is probable that these secondary peroxidase-peroxide complexes also have covalent bonding. These data show that the substrate can combine with the enzyme so as to alter profoundly the absorption spectrum and the nature of the chemical bonds in the enzyme.

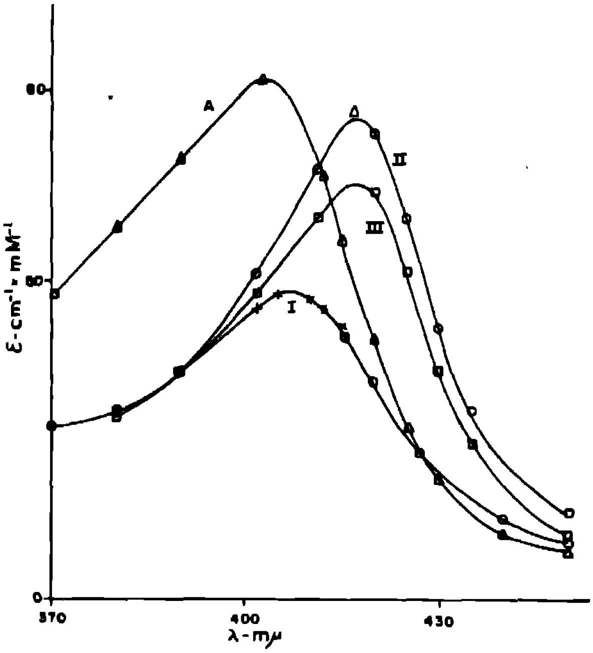


FIG. 1. The Soret bands of free peroxidase (A) and peroxidase combined with hydrogen peroxide to form the primary (I), secondary (II), and tertiary compounds (III). Complex I is very unstable and the points on this spectrum were measured by means of the rapid-flow apparatus. Under proper conditions, Complex II is relatively stable and both the rapid-flow apparatus and the Beckman spectrophotometer were used to measure its spectrum. Complex III forms in the presence of a large excess (10- to 100-fold) of hydrogen peroxide; its spectrum was measured in the Beckman spectrophotometer.

The reaction kinetics of the primary and secondary complexes. By timing the rate of formation of the primary complexes in the rapid-flow apparatus, the reaction-velocity constants for the union of peroxidase with peroxide molecules have been studied. In this very rapid reaction, the hydroxyl group bound by ionic bonds to the iron atom of peroxidase (*16*) is replaced by the peroxide group:

$$\underset{\text{brown}}{\text{Per}\cdot\text{OH}} + \text{HOOR} \xleftrightarrow[k_2]{k_1} \underset{\text{green}}{\text{Per}\cdot\text{OOR(I)}} + H_2O \qquad (1)$$

R may be H– (*18*), CH_3–, or C_2H_5–, and the values of k_1

for these substrates are given in Table 1. These enzymes combine with their substrates at about the same speed as muscle hemoglobin combines with oxygen (*13*).

TABLE 1

REACTION VELOCITY CONSTANTS FOR EQUATIONS 1, 2, AND 3

Enzyme	Substrate	k_1 ($M^{-1} \times sec^{-1}$)	$Km_3(M)$	k_7 (sec^{-1})	k_3 (sec^{-1})	k_4($M^{-1} \times sec^{-1}$) for ascorbic acid (pH 7.0)	k_4($M^{-1} \times sec^{-1}$) for pyrogallol (pH 7.0)
			for zero acceptor concentration				
Horse-radish peroxidase	hydrogen peroxide	1×10^7	1.5×10^{-6}	4.0	0.05	2,800	2.1×10^5
"	methyl-hydrogen peroxide	1.5×10^6	3×10^{-7}	4.0	0.03	2,800	2.1×10^5
"	ethyl-hydrogen peroxide	3.6×10^4	....	4.0	0.02	2,200	1.8×10^5
Lacto-peroxidase	hydrogen peroxide	2×10^7	1×10^{-6}	4.0	0.03	5,400	7×10^6
"	methyl-hydrogen peroxide	6×10^6	2×10^{-6}	4.0	0.03	2,700	....
"	ethyl-hydrogen peroxide	2×10^4	2×10^{-6}	4.0	0.02	2,100	....

Complex I is spontaneously converted into complex II in a first-order reaction:

$$\underset{\text{green}}{\text{Per}\cdot\text{OOR (I)}} \overset{k_7}{\longleftrightarrow} \underset{\text{red}}{\text{Per}\cdot\text{OOR (II)}} \qquad (2)$$

The oxidation reaction occurs on combination of the acceptor molecule (AH_2) with the secondary complex and results in the liberation of the free enzyme:

$$\underset{\text{red}}{\text{Per}\cdot\text{OOR (II)}} + AH_2 \xrightleftharpoons{k_4 = \frac{k_4'}{[AH_2]}} \underset{\text{brown}}{\text{Per}\cdot\text{OH}} + A + ROH \qquad (3)$$

The velocity constant (k_4) for the reaction of complex II with acceptor is here taken as a measure of the enzyme activity (see Table 1). The values of k_7 given in the table increase greatly when an acceptor is added. Therefore, the transition from complex I to complex II is not a rate-determining step in peroxidase kinetics. Only the combination of enzyme and substrate and their reactions with the acceptor are rate-determining steps in accordance with previous data (*4*). When $[AH_2] = 0$, complex II nevertheless spontaneously decomposes in a first-order reaction of rate k_3 (see Table 1).

In these studies, the utilization of peroxide by the enzyme system can be readily measured from the graph of the concentration of complex II as a function of time as shown in Fig. 2. Complete solutions of the equations for peroxidase kinetics (*4*) have shown that a simple relation exists between k_4 and values readily measured from the kinetics of complex II:

$$k_4 = \frac{[\text{HOOR}]}{[\text{Per}\cdot\text{OOH}-\text{II}]\,[AH_2]\,t_{\frac{1}{2}\text{off}}}\ M^{-1} \times sec^{-1} \qquad (4)$$

where [HOOR] and $[AH_2]$ are initial concentrations ($[AH_2] > [\text{HOOR}]$) and [Per · OOH (II)] is the maximum concentration to which complex II rises in the particular experiment. The quantity $t_{\frac{1}{2}\text{off}}$ is the time from $t = 0$ until the concentration of complex II has fallen to half its maximum value. Thereby the enzyme-substrate complex is used as a spectrophotometric indicator of its activity. This method permits studies of enzyme activity in the presence of substrate concentrations which are much less than those measurable by ordinary techniques. Thus enzyme inactivation caused by excessive substrate concentrations is avoided.

The values of k_1 given in Table 1 show that, usually, the reaction of enzyme and substrate is considerably more rapidly than the reaction of complex II with the acceptor. This is not a general rule; the reaction of complex II of lactoperoxidase and hydrogen peroxide with hydroquinone is nearly as rapid as the combination with hydrogen peroxide.

The values of k_4 show that lactoperoxidase is a more active enzyme with these two acceptors than is the plant enzyme. In addition, the milk enzyme combines more rapidly with hydrogen peroxide. These differences may be attributed to differences between the protein parts of these two enzymes.

In general, the peroxidase complexes formed from the substituted ~~peroxides react~~ just as rapidly with acceptors as do the complexes formed from hydrogen peroxide. The same result was obtained in the reactions of the catalase-peroxide complexes with alcohols and other substances (*6*). The rate of formation of the primary complexes, however, decreases somewhat with the substituted peroxides, possibly owing to a steric effect. This effect is much less with peroxidases than with catalases (*6*).

Fig. 2 illustrates the effect of using three different substrates upon the kinetics of complex II. With hydrogen peroxide, k_1 is largest, and the concentration of complex II rises to very nearly its saturation value. Because nearly all the enzyme is in the form of this reactive complex, the oxidation of ascorbic acid is rapid, and consequently the hydrogen peroxide is consumed in about two seconds. Since methyl hydrogen peroxide combines more slowly with peroxidase, the concentration of complex II rises to a smaller value in this test, and the consumption of the peroxide requires a longer time. A similar effect is observed with ethyl hydrogen peroxide. But in all three cases, the values of k_4 calculated from equation 4 are nearly the same (2,800, 2,800, and 2,200 $M^{-1} \times sec^{-1}$; see Table 1). The earlier conclusion of Wieland and Sutter (*20*) that the activity of horse-radish peroxidase with ethyl hydrogen peroxide is $\frac{1}{8}$ that with hydrogen peroxide is apparently incorrect.

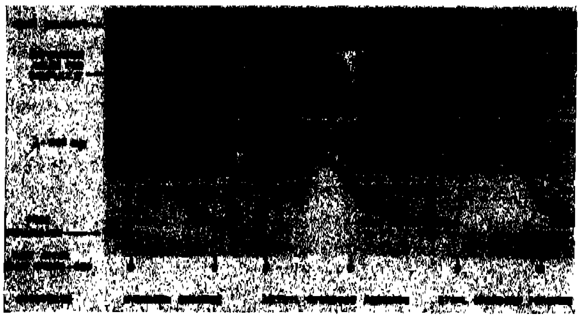


FIG. 2. Illustrating the use of the rapid-flow apparatus in the measurement of the rapid formation (fast rise of traces) and disappearance (slower fall of traces) of the enzyme-substrate complexes of horse-radish peroxidase (2.0×10^{-6} M) caused by reactions with hydrogen peroxide (3.6×10^{-6} M), methyl hydrogen peroxide (4.2×10^{-6} M), and ethyl hydrogen peroxide (3.2×10^{-6} M) in the presence of ascorbic acid (40×10^{-6} M). These three enzyme-substrate complexes are here used as spectrophotometric indicators of the peroxide concentration; the velocity of their reaction with ascorbic acid is calculated by equation 5. The results are given in Table 1.

In the absence of added acceptor, the very high affinity of the enzyme for its substrate can be demonstrated; Table 1 lists as Km_s the concentrations of peroxide which give the half-saturation value of complex II. These concentrations are much less than those required to half-saturate muscle hemoglobin with oxygen and about as small as the concentration of oxygen estimated to give half-saturation of the respiratory enzyme (*13*).

With horse-radish peroxidase, but not with lactoperoxidase, the values of k_7 and k_3 can be reduced more than tenfold by repeated additions of an equivalent of peroxide. But k_3 has never been reduced to zero; the enzyme-substrate compounds of both peroxidase and catalases slowly undergo "spontaneous" decomposition (whose mechanism is not understood) into the free enzyme.

The reversible decomposition of the enzyme-substrate complexes (k_2 of equation 1) does not appear to play an important role in the reaction kinetics; in fact, final proof of the existence of k_2 is lacking. Hence, the rapidly reversible combination of enzyme and substrate pictured in the theory of Michaelis and Menten (*12*) is not characteristic of these enzymes.

The relation between the enzyme-substrate bond and the activity. In peroxidase, the covalent secondary complex must be formed before oxidation of the acceptor occurs and the enzyme is liberated from the complex. But in catalases, the primary complex with presumably ionic bonds appears to react directly with the acceptor; the enzyme is liberated from the primary complex without the formation of a measurable amount of a secondary complex of the type that peroxidase forms. This fundamental difference in the mechanism of catalase and peroxidase reactions may ultimately be resolved by further search of an undiscovered covalent complex in catalase reactions. Nevertheless, based on the nine similar primary complexes of catalase, horse-radish peroxidase, and lactoperoxidase, which surely have the same bond type (probably ionic), there is support for the generalization that this type of compound of enzyme and substrate forms first and more rapidly than the covalent compound.

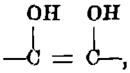
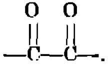
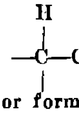
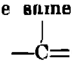
None of these oxidations caused by these hematin-peroxide complexes can be inhibited by carbon monoxide (*6, 7, 8, 10*), and therefore, the iron atom of these peroxidases is concluded to be trivalent and to remain trivalent in reactions with the substrates and acceptors.

The relation between heme-linked groups and activity. By a variation of the pH, linkages between the iron atom of peroxidases and the protein molecule can be altered, and their effect upon peroxidase activity may be determined. In alkaline solution above pH 9, peroxidase acquires a covalently bound hydroxyl group (*17*). Under these conditions the enzyme-substrate complexes do not form, and the enzyme is inactive, the effect being very similar to that observed when cyanide is bound to the iron atom of peroxidase by covalent bonds. Apparently the exchange reaction of equation 1 between the hydroxyl group bound by ionic bonds and the peroxide group is inhibited when the hydroxyl group is bound to the iron atom of peroxidase by covalent bonds.

The dissociation constant (Km_s) and reaction kinetics of the primary and secondary complexes of horse-radish peroxidase are found to be practically unchanged from pH 8.8 to 3.6. This is in accordance with studies of this particular peroxidase preparation which shows no changes of heme linkage in this pH region. Below pH 3.6, a change of heme linkage of pK 3.5 is found by direct spectrophotometric studies and by the effect of pH upon the dissociation constant of the horse-radish peroxidase fluoride and cyanide compounds.

In accordance with these data, the values of k_4 for the reaction of complex II with a number of acceptors show no systematic variation in the region pH 3.6 to 6.7. In general, nearly constant activity is found in this region, for example, in the case of hydroquinone, guaiacol, and pyrogallol. Where changes of k_4 are observed, changes in the course of the oxidation are also observed (leucomalachite green).

As a consequence of these experiments, the previous concept of sharp "pH optima" for peroxidases and catalases may be discarded. When the actual reaction velocity constants involved in the enzymatic activity are measured directly from the kinetics of the enzyme-substrate complex, errors caused by enzyme inactivation, by partial saturation of the enzyme with substrate, or by a variable lag between the disappearance of substrate and the appearance of a colored reaction product are eliminated. The activity is practically constant in the broad region where no changes of heme-linkages occur.

Acceptor specificity. Balls and Hale (*3*) generally describe peroxidase as a dehydrogenase removing two hydrogen atoms from different carbon atoms. Ascorbic acid, dihydroxymaleic acid, and *o*-dihydroxybenzenes are examples of the enediol group,  $-\overset{\text{OH}}{\overset{|}{\text{C}}}=\overset{\text{OH}}{\overset{|}{\text{C}}}-$, which on reaction with peroxidase-peroxide complexes is dehydrogenated to the diketo or o-quinone group,  $-\overset{\text{O}}{\overset{\|}{\text{C}}}-\overset{\text{O}}{\overset{\|}{\text{C}}}-$. Such a reaction is related to the action of catalase-peroxides on the  $-\underset{|}{\overset{\text{H}}{\overset{|}{\text{C}}}}-\text{OH}$ group of a lower alcohol, methylene glycol, or formic acid, where two hydrogen atoms attached to the same carbon atom are removed (*6*) to give the group  $-\overset{|}{\text{C}}=\text{O}$. While catalase has been found to be highly specific for small molecules of related structure, peroxidase-peroxides oxidize a wide range of rather different substances, for example, iodide or leucomalachite green. It is clear, however, that the broader acceptor specificity of peroxidase includes reactions analogous to those of catalase except that the two hydrogen atoms are attached to different carbon atoms. Since catalase hematin is accessible only to small molecules while peroxidase hematin is accessible to rather large molecules, further analogies between catalase and peroxidase specificity are difficult to demonstrate.

The oxidation of a number of substances previously considered to be inhibitors of peroxidase activity (*3*), e.g., phenol, aniline, resorcinol, and phloroglucinol, can be demonstrated by these more sensitive methods.

A particularly interesting reaction is the oxidation of ferrocytochrome C by the peroxidase-peroxide complexes. Contrary to the conclusions of Altschul, Abrams, and Hogness (*1*), horse-radish peroxidase has considerable activity in this reaction as does lactoperoxidase. At pH 4.6, the turnover numbers of these enzymes are $k_5 = 3.1$ and 2.5 sec^{-1}, respectively, as calculated from the rate of oxidation of ferro- to ferricytochrome C. In view of the acceptor specificity of peroxidase, it is more likely that the peroxidase-peroxide complex initially oxidizes the imidazole group of ferrocytochrome C and not the iron atom (see Theorell, *16*).

The ternary complex of enzyme substrate and acceptor. The kinetics of oxidation of ferrocytochrome C oxidation by the peroxidase-peroxide complexes, instead of being first order as equation 3 indicates, approximate the zero order until the ferrocytochrome C concentration has fallen to a small value. These reaction kinetics suggest that the rate-limiting step is the decomposition of a ternary complex of enzyme-substrate and acceptor:

$$\text{Per}\cdot\text{OOR (II)} + \text{AH}_2 \overset{k_4}{\longleftrightarrow} \text{Per}\cdot\text{OOR (II)}/\text{AH}_2 \overset{k_5}{\longleftrightarrow} \text{Per}\cdot\text{OH} + \text{A} + \text{ROH} \qquad (5)$$

Usually k_5 is fairly large—with pyrogallol it may be greater than 2,000 sec^{-1}. However, with ascorbic acid, k_5 is roughly 20 sec^{-1}. Values for k_5 in the oxidation of methanol by catalase peroxides are about 10 sec^{-1}. The unusually small value of k_5 ($\sim 3\ \text{sec}^{-1}$) in the ferrocytochrome C reaction is possibly caused by the complexity of the cytochrome C molecule and the stoichiometry of the reaction. There is ample kinetic evidence for equation 5 but, as yet, no spectroscopic evidence for such a ternary complex has been obtained (see also LuValle and Goddard, *11*).

Activity and oxidation-reduction potential. The velocity constant (k_4) for the reaction of complex II with acceptor molecules of different oxidation-reduction potential has been studied. First, the variation of pH from 3.6 to 6.7 causes no systematic decrease in the values of k_4 for hydroquinone, guaiacol, and pyrogallol, yet their oxidation-reduction potential decreases by 0.186 v because of this pH change (*2*). If hydroquinone is replaced by quinhydrone at constant pH, the value of k_4 calculated on the basis of the hydroquinone molarity is nearly constant. Thus other factors are much more important than oxidation-reduction potential in determining the value of k_4. For example, hydroquinone and pyrogallol have about the same oxidation-reduction potential but hydroquinone reacts about 10 times more rapidly ($k_4 = 25 \times 10^6$ compared to $2.1 \times 10^5\ \text{M}^{-1} \times \text{sec}^{-1}$).

It is concluded that the rates of these biological oxidations are remotely related to the oxidation-reduction potentials of the acceptors.

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Comments and Communications

Pressure Patterns in Bird Migration

Before I read H. Landsberg's suggestion (*Science*, December 24, p. 708) that, on migration, birds fly according to meteorological pressure patterns, I had come to a similar conclusion after an experience with the redwing (*Turdus musicus* L.). Redwings usually come from Norway to the east coast of the United Kingdom in autumn or early winter and gradually pass further south as the weather becomes colder. With the advent of warmer weather in spring, they retreat in the opposite direction. But this rule does not always hold, as is shown by a remarkable immigration which took place in February 1948 at Hill Head, Hants. The month opened with spring-like weather, alternating sunshine and showers, the wind being in the southwest. By February 7 the hazel catkins were out and the sallow buds were opening. On February 16 there was a sudden change—the weather was cold and dry with an east wind which blew for three days before shifting to the northeast. There was then a sprinkling of snow at night followed by slight snow. By next day it was freezing and more snow fell. On February 21 with the wind still northeast, there was a blizzard of snow which lasted most of the day. All through that day there was a continuous stream of small parties of redwings flying low and crossing the coast from the south. Next day, the snow lay four inches deep, a most unusual occurrence at Hill Head, and a few more redwings came in from the sea. The snow had stopped falling by that morning, and all day there were crowded parties of redwings, with a few fieldfares (*T. pilaris* L.), sheltering under the bushes in our garden.

Reference to the meteorological maps of that period shows that there was an anticyclone centered in the North Sea, with the result that snow must have fallen heavily in Scandinavia, obliterating the redwings' food supply, whereupon the birds must have taken to the air to seek fresh provender and have been carried by the wind of the anticyclonic pressure systems to Denmark, the Lowlands, and France, and thence to the south coast of England. Far from finding a new food supply, the birds had been carried helplessly along the outer edge of the pressure system, and thus remained in the area of snow precipitation, with the result that many of them died of starvation.

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On the Carcinogenesis of 2-Substituted Fluorenes

The noncarcinogenic coal-tar hydrocarbon, fluorene, is made carcinogenic by the introduction of such groups as acetylamino, diacetylamino, amino, and nitro in the 2 position (H. P. Morris, C. S. Dubnik, T. B. Dunn, and J. M. Johnson. *Cancer Res.* 1947, 7, 730–1). In a paper dealing with a biochemical hypothesis of the genesis of cancer (L. A. Pinck, *Ann. N. Y. Acad. Sci.*, 1948, 50, Art. 1, 1–17) it was postulated that the position of the substituent rather than its chemical composition was in a larger measure responsible for the functional attribute of the carcinogen. It was indicated that other substituents in the 2 position of the fluorene molecule, having electronegativities within certain limits in the range of that of the acetylamino group, might also make those fluorene derivatives carcinogenic. From a chemical viewpoint the methylene group in the 9 position of the fluorene molecule (encircled in Fig. 1) is greatly activated by the presence of a substituent in the 2 position. This point was confirmed by work recently published.

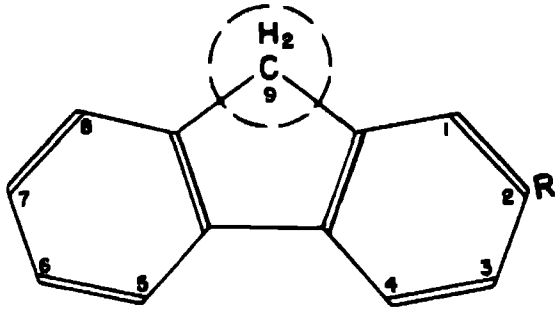

FIG. 1. A 2-substituted fluorene.

Schiessler and Eldred (*J. Amer. Chem. Soc.*, 1948, 70, 3958–9) found that 2-acetyl-fluorene is readily oxidized to fluorenone-2-carboxylic acid by the action of potassium hypochlorite at room temperature, whereas fluorene under the same conditions does not yield a trace of fluorenone. Ray, Weisburger and Weisburger (*J. org. Chem.*, 1948, 13, 655–662 reported that 9,9′-bifluoryl-2,2′-dicarboxamidine dihydrochloride is easily converted to the 9,9′-bifluorylidene derivative by air oxidation and that special precautions are necessary to prevent its oxidation in the course of crystallization. The chemical behavior of the above compound is quite different from that of 9,9′-bifluoryl. A change in the activity of the methylene group due to the presence of a nitro group in the 2 position of fluorene was also reported by other investigators (E. Bergmann, H. Hoffman, and D. Winter. *Ber.* 1933, 66, 46–54; A. Novelli and A. P. G. de Varela. *Ciencia E Investigacion* 1948, 82–84).

On the basis of the reactions cited above and those referred to in the cancer paper I should like to call the attention of oncologists to the very reactive nucleus of a carcinogenic fluorene, namely, the methylene group in the 9 position, and to the first step in carcinogenesis which obviously involves the oxidation of this particular group as postulated in my hypothesis.

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Oyster Mortality in Louisiana

In a recent comment (*Science*, October 29, pp. 484–485) Gunter apparently attempts to minimize the seriousness of the oyster losses in the State of Louisiana which have occurred and are continuing to occur. The use of statistics in such a connection can be very misleading without detailed study of the facts. Even though the total production remains stable or actually increases, it must be realized that this situation results from expansion of the industry through use of undeveloped grounds, of which Louisiana has an abundance, and of better utilization of producing grounds. It does not negate the fact that a continuing unexplained mortality may prevent the production from reaching even higher levels. Furthermore, once the expansion is completed, this mortality may then result in decline as the adverse factors causing this mortality continue and spread to other areas. This latter possibility has been in the minds of Louisiana oyster conservationists for some time. Because they are progressive and look into the future, they have good reason for alarm.

Conservation officials of the State have repeatedly asked the Fish and Wildlife Service to assist them with problems of unexplained and continuing severe oyster mortalities. As a result of those requests I was detailed to Louisiana for this work a few years ago. Unfortunately, the studies were discontinued abruptly because of the war. But even in this brief work, we saw sudden oyster deaths and watched many acres of oyster bottoms covered with excellent oysters change into acres of empty shells. Oystermen sustained heavily financial losses, the production of their ground dropping to zero. It cannot be denied that serious mortalities have occurred and are of great concern to the oyster industry of Louisiana. The seriousness of such losses should not be overlooked for their is danger that the factor or factors bringing about these mortalities may continue to spread.

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Biological Education in Secondary Schools

The increase in food production which has been accomplished in spite of a shortage of labor is the result of the application of scientific principles to farming. This is modern agriculture, and it has little in common with the traditional ideas of peasant farming. The effective use of fertilizers of high yielding varieties, of chemicals which control insects, nematodes, and weeds, of better agricultural machinery, and of better agricultural practices have all contributed to making this nation a leader in agriculture. What are we doing to maintain this leadership in the future? Do we adequately acquaint the coming generations with the basic principles of biology, chemistry, and physics upon which rests our future in agriculture?

Like so many other biologists, I have watched with apprehension the appalling lack of appreciation of the importance of the teaching of biology at the secondary school level in this country. To me it seems obvious that, if we are to keep our leading position, we will have to gear our educational system to modern agriculture. This cannot be done adequately without making biology a required subject in all secondary schools.

Other countries have long realized the importance of indoctrinating their coming generations in the principles of biology. In Holland, long a leader in the field of intensive agriculture in their home country and the tropics, every student attending secondary school receives five full years of training in zoology and botany. This has contributed much in providing the Dutch empire with a steady supply of workers necessary in all the phases of a complicated economy based on modern agriculture. Training of this sort provides a suitable basis for further specialization. In addition, it has great cultural value in that a larger section of the population obtains a better understanding of the problems which confront an agricultural economy.

In this country we could well profit by this example and embark on an educational program which will make the nation aware that our economy actually rests on biological principles. High school courses could start profitably during the freshman year with a simple course in human anatomy. Young people are very interested in themselves; hence such a course would logically serve as an introduction to biology. Gradually the student should become acquainted with other forms of life that exist in the world around us. In an age of synthetic chemicals we tend to forget that the source of energy which makes human beings go is still derived from food, for which we are dependent upon plants and animals. Courses in biology should therefore include animal and plant taxonomy, morphology, and anatomy. During the final years, when the student is acquiring knowledge of physics and chemistry, some of the principles of animal and plant physiology could be taught. This emphasizes the desirability of teaching biology as an integral part of a required course in basic science.

We are well aware that our store of scientific knowledge has increased enormously during the past decades, and one would therefore be inclined to think that teaching of basic science at the secondary school level would hopelessly overcrowd the curriculum with complicated courses. This is not necessarily so. On the contrary, we are now in a position to teach the principles and omit the frills. As Pauling has stated in the introduction of his new chemistry book: "Nevertheless, despite its growth (the) science can now be presented to the student more easily and effectively than ever before."

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In Memoriam

Wesley Clair Mitchell

1874–1948

When Wesley Mitchell started the National Bureau of Economic Research in 1920, the work and the teaching of economics were largely a speculative exercise. Concepts such as "normal value" and "marginal utility" held the center of the stage. Wesley Mitchell brought to this thinking a simple but radical program. Without minimizing the role of theory in economics, Dr. Mitchell held that it was possible to substitute fact for conjecture and tested conclusion for hypothesis. He developed what was, in my judgment, the most majestic research conception that any economist or group of economists has yet produced. By measuring and analyzing continuingly the central flows of our economic life, he undertook to find out "what has really happened" and "what is happening," and thus lay a foundation for the third question, "why?" No economist of our time has contributed so fundamentally to building a body of verified economic knowledge.

But the heart of my thought today is this: What did Wesley Mitchell, the man, contribute to Wesley Mitchell, the scholar?

In the social sciences the nature of the problems, the nature of the data, the less mature development of methodology, and the tremendous pressures on students to jump to conclusions, or to some special conclusion, make it inevitable that a larger share of the needed controls and defenses must exist in the character and spirit of the scholar than is the case in the physical and biological sciences. And Dr. Mitchell had those inner qualities that multiplied the value of his scholarship and enhanced its influence among all men.

Dr. Mitchell had one of the cleanest-cut, most analytical minds I have ever encountered, and a memory to match. His role was to discover truth, and its discovery remained a holy experience with him to his dying day. It was not enough to say a contribution was original or ingenious or plausible or logical. He insisted on establishing methods which would answer the ultimate question: "Is it true to life?" No matter how difficult, complicated, or costly in time and effort, Mitchell demanded the answer to that question. He was a perfectionist,—a determined, persistent, working perfectionist. The words which Dr. Arthur F. Burns, Director of Research of the National Bureau, recently used to describe the qualifications needed for fruitful empirical research in economics were, in effect, a description of Wesley Mitchell and his steadfastness of purpose and method:

> "He must have the patience to examine with meticulous care the economic coverage and representativeness of the statistics that lie at hand; the enterprise to seek out remote and inaccessible bodies of information; the imagination and technical skill to devise appropriate methods of relating, combining, reducing, or decomposing statistical observations; the personal industry or the clerical assistance to carry through these laborious operations; the common sense to make full use of nonquantitative information about commercial markets and processes; the conscience to test results repeatedly against fresh observations; the character to scrap results if error or unconscious bias is spotted; the fortitude to expose his materials and methods to the public's gaze; the wisdom to seek the help of others who might make his own best efforts obsolete."

The thing which stands out in my mind about Mitchell's work was its emphasis on quality and the thoroughness with which he did a job so that it did not need redoing by the next person who came along. The fundamental conception which permeated Mitchell's philosophy of work was precisely the conception that each man should be able to build on what went before without having to redo the entire structure. He believed and practiced the theory that the function of research people was to provide bricks for a building, and that each man should not take as his own job the building of the whole structure. To give one small example, I refer to Mitchell's little classic on index numbers. This is a subject on which a great deal has been written by a great many people. Much of the work has been more flashy than Mitchell's; yet his classic is by far the best thing available on the subject. He did a job that needed to be done, and he did it once and for all. He laid his bricks in a foundation upon which others could build firmly.

This emphasis on quality of workmanship as a prerequisite for making economics a cumulative science seems to me to be the most important element in Mitchell's methodological position.

A personal characteristic that strengthened his capacity to attain this quality was his ability to take criticism. Three years ago he told a colleague: "I hope I finish this job on which I am now working before I become too old to take criticism." I doubt whether any colleague of Mitchell's can recall when he ever took personally any criticism directed at himself; he always reached out to such criticism with eager sympathy and an open mind. Where critical himself, he was never carpingly so, but always considered ideas and developments in their proper and therefore explanatory setting. And he expressed his own ideas with exceptional clarity and elegance. A great essayist was lost when Wesley Mitchell turned to economic reasearch.

So far, I have been discussing chiefly Mitchell's qualities of mind and character. I turn now to his more personal qualities as a colleague who was also a delightful human being. I think first of his humility. Once, when Moore's mathematical approach to business cycles was under discussion, a colleague commented upon its originality, and Mitchell replied, "I am not so brilliant and I find my mind moves more slowly." The impression he created on this colleague was that of a man who was modest to the point of humility about the capacity of his mind to undertake ambitious flights of imagination, and therefore of his imperative need to go step by step as the data revealed one connection after another. But Dr. Mitchell's humility did not prevent his doing an artistic job of calling a man down when he needed it.

With this undue modesty about himself, Wesley Mitchell had an inveterate respect for other scholars. His humility was fused with his optimism. This optimism was partly reflected in his respect for the human mind, partly implicit in his stress on empirical investigation. A man must be a fundamental optimist to believe that human intelligence, regardless of the limitations it has shown, can be firmly counted on to add something useful; to believe that all workers in a field deserve respect because they all contribute within their capacities to the ultimate result. And a man rejects preconceived prejudices and instinctive reactions when he stresses the importance of accumulating data and relating them, item by item, to increasingly relevant hypotheses for the understanding of social processes. Such a man must believe implicitly in human responsiveness to objective knowledge. I can explain in no other way the kindly readiness that he always displayed to assist younger workers who became impatient with the recalcitrance of the data, or who lost faith in the possibility of deriving beneficial conclusions from empirical study.

In spite of the tremendous discipline he enforced on himself, Mitchell was always ready to give of his time, his thought, and his work unsparingly to others. One friend said to me on his death:

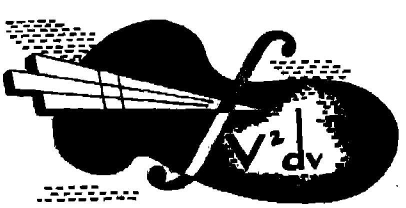
"I did not know Dr. Mitchell well, yet I deeply feel his death. This is because of his spontaneous sympathy. He was really concerned with what you were doing and thinking, and he showed it. The few times I talked with him, always briefly, left me with a kind of renewal of spirit, a kind of resistance to a feeling of futility. If these brief and casual contacts would evoke such a feeling of fellowship, how much greater must have been his influence on those who knew him more intimately. It was the warmth of his personality that left its impression on me. It is my belief that in academic circles there is a certain tendency for older men to make casual encounters an occasion for impressing their own superiority upon their juniors. Dr. Mitchell did not do that. He assumed an equality that did not exist except on one level, the level of effort and aspiration. But that is perhaps the only sound level of human footing. It is my opinion that this trait has had much to do with the character of the National Bureau."

Wesley Mitchell was a man of integrity, of enormous tolerance, and catholicity of spirit. He was a scholar with a fairness and objectivity that no one ever questioned—a human being with gaiety and an infectious sense of humor. I hope that all scientists will read the lessons of his character and spirit, along with the lessons from his mind, and thus help to keep these qualities viable.

(In these remarks, made at the memorial meeting held for Dr. Mitchell at Columbia University, December 4, 1948, I have drawn freely, without specific acknowledgment, on conversations and correspondence with my own colleagues and former colleagues and friends of Dr. Mitchell's including Anne Bezanson, Arthur F. Burns, William J. Carson, Milton Friedman, Simon Kuznets, Frederick C. Mills, Roswell C. McCrea, Robert Warren, and Leo Wolman.)

JOSEPH H. WILLITS

The Rockefeller Foundation, New York City



Book Reviews

A text-book of mathematical analysis: the uniform calculus and its applications. R. L. Goodstein. Oxford, Engl.: Clarendon Press; New York: Oxford Univ. Press, 1948. Pp. xii + 476. $9.00.

In presenting this rigorous book on calculus the author has attempted to avoid difficult fundamental items like the Dedekind theory of real numbers or the proof of uniform continuity of functions continuous in an interval.

The basic theory of real numbers is given in the form of a precise theory of infinite decimal fractions, culminating in the classical theorem that nests of intervals determine a number. From here the author could have proceeded in the usual way. But he wants to simplify the theory by introducing only "uniform continuity" (instead of continuity in general) and only uniform differentiability of $f(x)$ (instead of differentiability in general). This expression means that the derivative $f'(x)$ is defined in such a manner that it is uniformly continuous in the considered closed interval $[a, b]$. His definition is equivalent to the following: For every $\varepsilon > 0$ there exists a $\delta > 0$ such that

$$\left| \frac{f(X) - f(x)}{X - x} - f'(x) \right| \leq \varepsilon$$

if X, x are in $[a, b]$ and $0 < |X - x| \leq \delta$.

The author's procedure restricts the generality of the usual calculus somewhat. On the other hand, he is able to emphasize constructive proofs and avoids such theorems as the Heine-Borel covering theorem or the Bolzano-Weierstrass theorem. It seems therefore that his philosophy of mathematics has induced the author to develop his presentation of calculus. Whether many mathematicians will like his approach remains to be seen.

ARTHUR ROSENTHAL

Purdue University

Sequence in layered rocks: a study of features and structures useful for determining top and bottom or order of succession in bedded and tabular rock bodies. Robert R. Shrock. New York-London: McGraw-Hill, 1948. Pp. xiii + 507. (Illustrated.) $7.50.

Sequence in layered rocks should enjoy extensive use because it brings together in very usable form a large mass of detailed information about original structures of rocks that heretofore has been widely scattered through the literature. Field men particularly will find this book a useful one to include in a limited field library.

Dr. Shrock apparently has in mind the problem that confront field geologists dealing with highly folded rocks because his avowed purpose in writing the book is to assemble information that will assist in the discrimination of tops and bottoms in folded layered rocks. Though admirable in itself, the purpose seems to understate the actual achievement of the book.

A unique and commendable feature of the book is the very extensive use of line diagrams and photographs, many of them original, over detailed descriptions of the features portrayed; so that the reader sees as well as reads about the subject simultaneously.

Approximately 60 pages are devoted to definitions and to a review of what the author terms "gross relationships." This latter feature sets forth the author's views on such basic concepts as superposition, faunal succession, unconformity, intrusion, comparative deformation, and comparative metamorphism.

More than half of the book is devoted to setting forth detailed features of sedimentary rocks. Original structures of all kinds are illustrated and discussed. Individuals engaged in sedimentary studies will find these sections especially welcome, not only because the features are adequately illustrated and explained, but because an extensive indexed bibliography accompanies the volume, thus simplifying the problem of assembling additional information about a feature.

Additional chapters on detailed original structures in igneous and metamorphic rocks, though not as extensive as those that deal with sediments, nevertheless seem adequate for the purpose of the book.

WARREN O. THOMPSON

University of Colorado

Bibliography of animal venoms. R. W. Harmon and C. B. Pollard. Gainesville, Fla.: Univ. Florida Press, 1948. Pp. xxx + 340. $8.00.

The value of a complete bibliography concerning a particular subject, properly indexed, is undoubted. The time saved a worker in having an immediate source of information concerning the literature on his subject is usually sufficient to make the time necessary to compile the information well spent. This, unfortunately, is not entirely the case in the present bibliography. The authors have done a tremendous amount of work in its preparation and are to be congratulated upon a fine piece of work, albeit incomplete.

The authors have listed 4,157 titles dealing with animal venoms published since 1875 (rather than 1863, as stated in the foreword). These titles are arranged chronologically by year of publication of the original references, and alphabetically by author under each year. Citations are given to abstracts of the paper as well as to the original publication. Titles in foreign languages have been translated, and all titles are given in English. Ten abstracting journals have been used extensively, and the list of abbreviated journal names is indeed impressive. There is an index of authors whose works are mentioned.

In view of the exhaustive and painstaking work involved in preparing what has been done, it comes as a surprise to find that there is no cross indexing whatsoever, except for the index of authors. The fact that there is no subject index greatly decreases the value of the book. It is hoped that this is only volume 1 and that the next will include a complete cross reference of the material. As it stands, one must start on page 1 and read every title to find those related to a special interest. Even so the book will save some time for the researcher.

It is also surprising to find the *Zoological Record* missing from the list of references consulted. A quick check of its cross reference of venoms in the Amphibia and Reptilia section shows that only about 50% of the titles listed there are also in this book; e.g. in 1939, of 27 titles in the *Zoological Record*, only 14 were also listed in this book. The same is true of 1944 and 1945. In 1946 only 3 of the 18 titles related to venoms in the *Zoological Record* appear in this volume. The last may be due to publication delays, of course. Possibly too much dependence has been placed upon abstracting journals rather than on direct checks of the journals concerned. This is shown by the presence of some and absence of other articles which have appeared in *Copeia*. For example, neither Cowles' article on venom in *Hypsiglena* (*Copeia*, 1941, 1, 4) nor Allen and Maier's note on extracting and processing of snake venom (*Copeia*, 1941, 4, 248) is listed, although the senior author of the second paper gave assistance to the authors in the book's preparation! These omissions, though unfortunate, are a normal occurrence in this kind of book and would be cheerfully disregarded if a subject index were available. The lack of the latter, however, makes this volume of doubtful value in a zoologist's library. The book will be useful primarily to those who only wish to know the field of venom well enough to be acquainted with the work done by various authors and the time when such work was done.

JAMES A. PETERS

University of Michigan

Scientific Book Register

ARNOW, L. EARLE, and REITZ, HENRY C. *Introduction to organic and biological chemistry.* (2nd ed.) St. Louis: C. V. Mosby, 1949. Pp. 795. (Illustrated.) $5.75.

CALVIN, MELVIN, HEIDELBERGER, CHARLES, REID, JAMES C., TOLBERT, BERT M., and YANKWICH, PETER F. *Isotopic carbon: techniques in its measurement and chemical manipulation.* New York: John Wiley; London: Chapman & Hall, 1949. Pp. xiii + 376. (Illustrated.) $5.50.

CURTIS, BRIAN. *The life story of the fish: his morals and manners.* New York: Harcourt, Brace, 1949. Pp. xii + 284. (Illustrated.) $3.75.

HOFBAUER, LUDWIG. *Atemregelung als Heilmittel.* Vienna, Austria: Wilhelm Maudrich, 1948. Pp. 99. (Illustrated.) $2.50.

McDOUGALL, W. B. *Plant ecology.* (4th ed.) Philadelphia: Lea & Febiger, 1949. Pp. 234. (Illustrated.) $4.00.

MILNE, E. A. *Vectorial mechanics.* New York: Interscience, 1948. Pp. xiii + 382. (Illustrated.) $7.50.

OEHSER, PAUL H. *Sons of science: the story of the Smithsonian Institution and its leaders.* New York: Henry Schuman, 1949. Pp. xvii + 220. (Illustrated.) $4.00.

POST, HOWARD W. *Silicones and other organic silicon compounds.* New York: Reinhold, 1949. Pp. 230. (Illustrated.) $5.00.

RIDER, JOHN F. *Installation and servicing of low power public address systems.* New York: John F. Rider, 1948. Pp. iii + 204. (Illustrated.) $1.89.

RILEY, GARDNER M. *Essentials of gynecologic endocrinology: with sections on the male.* Ann Arbor, Mich.: Caduceus, 1948. Pp. x + 205. (Illustrated.) $3.00.

RONCHESE, FRANCESCO. *Occupational marks and other physical signs: a guide to personal identification.* New York: Grune & Stratton, 1948. Pp. xvi + 181. (Illustrated.) $5.50.

ROSENFELD, L. *Nuclear forces.* (Sect. II.) Amsterdam: North-Holland Publ.; New York: Interscience, 1949. Pp. 182–543. (Illustrated.) $7.50.

SNYDER, FRANKLIN F. *Obstetric analgesia and anesthesia: their effects upon labor and the child.* Philadelphia-London: W. B. Saunders, 1949. Pp. viii + 401. (Illustrated.) $6.50.

STIMSON, DOROTHY. *Scientists and amateurs: a history of the Royal Society.* New York: Henry Schuman, 1948. Pp. xiii + 270. (Illustrated.) $4.00.

SYMONDS, PERCIVAL M. *Dynamic psychology.* New York: Appleton-Century-Crofts, 1949. Pp. vii + 413. $3.75.

WALTON, HAROLD FREDERIC. *Inorganic preparations: a laboratory manual.* New York: Prentice-Hall, 1948. Pp. viii + 183. (Illustrated.) $3.00.

WARE, LAWRENCE A. *Elements of electromagnetic waves.* New York-London: Pitman, 1949. Pp. x + 203. (Illustrated.) $3.50.

WEISSBERGER, ARNOLD. (Ed.) *Catalytic, photochemical and electrolytic reactions.* (Technique of Organic Chemistry, Vol. II.) New York: Interscience, 1948. Pp. ix + 219. (Illustrated.) $5.00.

WERFF, J. TH. VAN DER. *Biological reactions caused by electric currents and by X-rays.* New York: Elsevier, 1948. Pp. xii + 203. (Illustrated.) $5.00.

———. *Annual report of the Smithsonian Institution, 1947.* (Publ. 3921.) Washington, D. C.: U. S. Govt. Printing Office, 1948. Pp. ix + 471. (Illustrated.) $2.00.

NEWS and Notes

Robert Gordon Douglas has been appointed professor of obstetrics and gynecology at Cornell University Medical College and obstetrician and gynecologist-in-chief to the New York Hospital. He has been serving as acting director of the joint position since the death of **Henricus J. Stander** last year.

M. L. Crossley, of the American Cyanamid Company, has been made an honorary member of the American Institute of Chemists.

Wilfred F. L. Place has recently been appointed general manager of Abrasifs Durex, Gennevilliers, France.

Franz L. Alt has been appointed assistant and acting chief of the Computation Laboratory of the National Bureau of Standards. Before joining the staff, Dr. Alt was deputy chief of the Computing Laboratory of the Ballistic Research Laboratories, Aberdeen Proving Ground, Maryland.

Harry Helson, of Bryn Mawr College, has been appointed professor and chairman of the Department of Psychology at Brooklyn College, effective next September. **Edward Girden** is now serving as acting chairman.

Howard E. Brewer, formerly associate botanist at Alabama Polytechnic Institute, recently became assistant professor in the Department of Botany, State College of Washington, Pullman.

H. A. Krebs, professor of biochemistry, University of Sheffield, England, will deliver the sixth Harvey Lecture of the current series at the New York Academy of Medicine on March 17. Dr. Krebs will speak on "The Tricarboxylic Acid Cycle."

Ernst Mayr, of the American Museum of Natural History, New York, has been elected a corresponding member of the Zoological Society of London.

Clement J. Rodden, chief of the Uranium and Related Materials Section of the National Bureau of Standards, has been named director of the New Brunswick Laboratory of the U. S. Atomic Energy Commission, effective April 3. Other staff appointments are: as assistant to the director, **John E. Donovan**, National Bureau of Standards; as chief of the General Analytical Branch, **Joseph J. Tregoning**, National Bureau of Standards; as chief of the Radiochemistry Branch, **James E. Hudgens**, Oak Ridge National Laboratory; and as chief of the Spectrographic Branch, **Harold R. Mullin**, Shell Oil Company research laboratories.

Frank J. Dunn, formerly of Columbia University, has joined the staff of the University of California Los Alamos Scientific Laboratory's Chemistry and Metallurgy Division.

John W. Ferree, former Indiana Health Commissioner, has been appointed director of the Public Health Division of the American Heart Association.

Visitors to U. S.

Ronald Smelt, formerly of the Royal Aircraft Establishment, England, has been appointed chief of the Applied Mechanics Subdivision at the Naval Ordnance Laboratory, White Oak, Maryland. Mr. Smelt's book on rockets and jets is in process of publication in England.

Thomas G. Room, chairman of the Department of Mathematics, University of Sydney, is serving as visiting professor of mathematics at the University of Tennessee during the current winter quarter.

Fred Jonker, University of Delft, Holland, has joined the University of Delaware's Department of Chemical Engineering as assistant research professor. Dr. Jonker, a specialist in the problems of jet engines, will work with Kurt Wohl in combustion research related to jet propulsion.

Hans Laser, of the Molteno Institute, Cambridge, recently arrived in New York to work on a special problem sponsored by the American Cancer Society, which is concerned with the study of Hodgkin's disease. Dr. Laser is a guest of the Research Laboratory of St. Vincent's Hospital. While here he will visit a number of universities and institutes in connection with his recent work on the chemotherapy of malaria, in behalf of the Medical Research Council of Great Britain.

Four European medical scientists are attending a one-month course on the use of radioisotopes at the Oak Ridge Institute of Nuclear Studies. They are: **Jean Govaerts**, University of Liége; **Robert Delcourt**, University of Brussels; **H. J. Jongepier**, University of Amsterdam; and **Alexander Robert Taylor Lundie**, of the Royal Army Medical Corps, England.

Enrico Volterra, of Rome, Italy, has been appointed associate professor of mechanics at Illinois Institute of Technology. Dr. Volterra taught mechanics and structures at Rome University and did research on structural problems and materials testing at Cambridge University.

Grants and Awards

Henry C. Sherman, Mitchell professor emeritus of chemistry at Columbia University, has been awarded one of the 1948 Charles Frederick Chandler medals.

Gilbert E. Doan, head of the department of metallurgy and metallurgical engineering at Lehigh University, has received the Stoughton Award for outstanding contributions to the advancement and use of welding. Dr. Doan helped to develop the use of gamma-rays for inspection of welds and castings.

Dontcho Kostoff, director of the Institute for Applied Biology and Organic Development, Academy of Sciences, Sofia, Bulgaria, has been awarded the Medal for Service in Agriculture and Forestry, presented for the first time this year by the Institute for International Relations in Agriculture and Forestry of Prague.

James Zetek was recently awarded the Vasco Nuñez de Balboa decoration by the Republic of Panama in recognition of his work on entomological problems of Panama and the Canal Zone. Mr. Zetek is presently in charge of the Ancon (Canal Zone) laboratory of the Bureau of Entomology and Plant Quarantine, U. S. Department of Agriculture.

Morris E. Leeds, chairman of the board of Leeds and Northrup Company of Philadelphia, recently received the 1948 Edison Medal of the American Institute of Electrical Engineers. Mr. Leeds was cited for his work with electrical precision measuring devices and controls.

Eugene G. Rochow, of Harvard University, has been chosen to receive the third Leo Hendrik Baekeland Award of the American Chemical Society's North Jersey Section. Dr. Rochow was cited for his research on compounds of silicon. The award, established by the Bakelite Corporation, consists of a gold medal and $1,000, presented biennially to an American chemist.

The National Geographic Society has awarded the Burr prize of $1,000 to **Arthur A. Allen**, professor of ornithology at Cornell University, for his leadership of an expedition which located the nesting place of the bristle-thighed curlew in western Alaska.

Anna Goldfeder has received an award from the Radiological Society of North America in recognition of her work in radiobiology, particularly for "Anomalous Radiosensitivities of Analogous Mouse Mammary Adenocarcinomas." Dr. Goldfeder is in charge of Cancer Research, Department of Hospitals, New York City, and Department of Biology, New York University.

The Gold Medal of the American Academy of Orthopedic Surgery has been awarded to three University of Texas staff members—**G. W. N. Eggers**, professor of orthopedic surgery, **Thomas Shindler**, resident in orthopedic surgery, and **Charles M. Pomerat**, director of the Tissue Culture Laboratory.

Colleges and Universities

The University of Delaware has appointed Earl Parker Hanson chairman of its Department of Geography. The Department's research will be integrated with the work of the University's Institute of Inter-American Studies and Research and will be aided by other departments, such as engineering, economics, and agriculture. A contract has been signed with the Office of Naval Research for a report on problems of adaptation to the humid tropics.

The Yale University Graduate School and School of Medicine are initiating a new program for the study of microbiology. The new department, which includes faculty members from four Graduate School Departments and the Medical School's Section of Preventive Medicine, will bring together courses previously offered by the Departments of Bacteriology and Immunology, Plant Science, Physiological Chemistry, and Zoology.

Harvard University's Mallinckrodt Chemical Laboratory has placed on display 45 pieces of scientific apparatus used at Harvard during the Colonial period. The equipment includes electricity-making machines designed by Benjamin Franklin, chemical devices invented by Joseph Priestley, a "camera obscura" (forerunner of the modern camera), and other instruments used in astronomy, optics, mechanics, electrostatics, hydrostatics, pneumatics, biology, magnetism, chemistry, and minerology. The collection was assembled under the direction of David Wheatland of the Physics Department.

Columbia University's Industrial Engineering Department, in cooperation with the Department of Sociology, is conducting a 4-month seminar in "The Theory of Organization and Management." The human element in production will be studied by engineers, social scientists, and industrial executives. Sessions are held Tuesday from 2–4 p.m. in Room 308, Mines Building, Columbia University, Broadway and 117th Street, New York City.

The Massachusetts Institute of Technology will hold an international convocation on the social implications of scientific progress, March 31–April 1. The subjects will be "The Twentieth Century, Its Promise and Its Realization," and "What the Nation Expects of Science and Technology." Speakers will include Karl T. Compton, chairman of the Research and Development Board of the National Military Establishment; Sir Henry Tizard, chairman of the British Ministry of Defense's Research Policy Committee; Fairfield Osborn, president of the New York Zoological Society; Percy W. Bridgman, Hollis professor of mathematics and natural sciences, Harvard University; Jacques Maritain, professor of philosophy, Princeton University; and Sir Richard Livingstone, of Oxford University.

Summer Programs

Yale University's annual Summer School of Alcohol Studies will be held in two sessions this year: at Trinity University, San Antonio, Texas, from June 6 to June 29; and at Yale from July 8 to August 5. E. M. Jellinek, director of the school, will be assisted by lecturers from other universities and representatives from other institutions of education, research, treatment, and rehabilitation. Applications for admission to the western session will be received up to *April 1*; for the eastern session to *April 15*. A prospectus and application blank for either session may be obtained from the Executive Secretary, Summer School of Alcohol Studies, Yale University, New Haven, Connecticut.

Duke University will hold its 9th annual session of the Institute for Mathematics Teachers, August 8–19 at Durham, North Carolina. The general theme of the Institute will be "Mathematics at Work" which will be presented in 10 study groups. Programs with detailed information will be available April 1 from W. W. Rankin, Professor of Mathematics, Duke University, Durham, North Carolina.

University of Michigan's College of Engineering is sponsoring a symposium on engineering structures this summer. S. P. Timoshenko, Stanford University, will give a course in "Theory of Plates and Shells," and R. V. Southwell, Imperial College of Science and Technology, London, will present "Relaxation Methods with Application to Aircraft Structures." Advanced courses in plasticity, dynamics, theory if structures, elasticity, and other related subjects will also be offered as well as an extensive program in applied mathematics. Further information may be obtained from E. L. Eriksen, Engineering Mechanics, University of Michigan, Ann Arbor.

The University of Virginia will conduct summer courses in botany, zoology, and biology at Mountain Lake Biological Station from June 16–August 24. Application blanks and further information may be obtained from the Registrar, Summer Session, University Station, Charlottesville, Virginia.

Industrial Laboratories

Television in natural color for the teaching of surgery and medicine will be demonstrated at the annual meeting of the American Medical Association at Atlantic City in June. This program, sponsored by **Smith, Kline and French Laboratories** of Philadelphia and the University of Pennsylvania, will enable large groups of medical students to study surgical techniques and medical procedures in full color detail.

The Laboratory of Microchemistry, formerly at 366 Fifth Avenue, New York City, is now located just outside the city at 705 George Street, Teaneck, New Jersey. The Laboratory is under the direction of Carl Tiedcke, its founder.

Meetings and Elections

The "Atlantic Ocean Basin" is the subject of a lecture series being presented at a number of colleges and universities by Maurice W. Ewing, professor of geology, Columbia University, and research associate, Woods Hole Oceanographic Institution, under the sponsorship of the Sigma Xi National Lectureships. The three remaining lectures of the series will be given February 28 at the University of Cincinnati, Ohio; March 1—Ohio University, Athens; and March 4—University of Tennessee, Knoxville.

Wellesley College will hold a 3-day Science Conference March 16–18. The theme of the all-college conference is energy, and James Bryant Conant, president of Harvard University, will deliver the keynote address, ''Science and Common Sense.'' Among the other speakers will be Gerty Cori, Nobel prize winner; Cecilia Payne-Gaposchkin, of Harvard Observatory; Robert F. Bacher, of the U. S. Atomic Energy Commission; Wolfgang Köhler, leader of the Gestalt system of psychology; and Edmund W. Sinnott, director of the Sheffield Scientific School of Yale University. Delegates from 70 colleges are expected to attend.

A 2-day symposium on ''Organic Sulfur Compounds as Related to Petroleum'' will be held in connection with the national meeting of the **American Chemical Society** in San Francisco, March 28–April 1. The best methods of combating the costly effects of sour crude oil, which derives its undesirable properties from its high sulfur content, will be presented in 29 technical papers by oil chemists of Great Britain and the U. S. Arlie A. O'Kelley, vice chairman of the Division of Petroleum Chemistry, will preside.

The newly formed **Inter-Society Corrosion Committee** of the National Association of Corrosion Engineers will hold its 1949 conference during the week of April 11, in Cincinnati, Ohio, coincident with the NACE 1949 conference.

The International and Fourth American Congress on Obstetrics and Gynecology will meet at the Hotel Statler (formerly Hotel Pennsylvania), New York City, May 14–19. Topics under discussion will be physiology of human reproduction, the pathology of human reproduction, social and economic problems, neoplastic diseases of the reproductive system, and obstetric and gynecologic procedures. All inquiries regarding the meeting should be addressed to Fred L. Adair, 24 West Ohio Street, Chicago 10, Illinois.

The American Society of Electroencephalography will hold its annual meeting in Atlantic City at the Chalfonte-Haddon Hall Hotel, June 11–12. Those wishing to submit papers should send two copies of title and abstract to Secretary Robert S. Schwab, Massachusetts General Hospital, Boston 14, and one copy to the proper representative on the Program Committee before *April 1*. Members are invited to submit demonstrations and exhibits, a description of which should also be submitted before April 1. Accepted papers will be announced by April 15.

The annual conference of **Health Officers and Public Health Nurses of New York State** will be held June 20–23 at Lake Placid. The Association of School Physicians will hold its annual meeting on the opening day.

The Heat Transfer and Fluid Mechanics Institute will hold its annual meeting June 22–24 on the University of California's Berkeley campus. The conference will be presented by California engineering colleges and engineering and scientific societies. A number of technical papers dealing with phases of the fundamental nature of heat transfer and fluid flow will be presented. For further information, write: Department of Institutes, University of California Extension, Berkeley.

The Special Committee on Fungi for the International Botanical Congress at Stockholm has made the following new appointments; Johanna Westerdijk, Netherlands; D. P. Rogers, C. W. Emmons, and G. W. Martin, U. S.; Rolf Singer, Argentina; S. P. Wiltshire, England; M. Le Gal, France; M. A. Donk, Dutch East Indies; and B. B. Mundkur, India. Previous appointees are C. L. Shear, K. B. Boedijn, R. Ciferri, R. Maire, J. A. Nannfeldt, F. Petrak, F. J. Seaver, E. M. Wakefield, A. M. Bottomley, W. J. Lütjeharms, J. Ramsbottom, A. Trotter, and W. H. Weston. T. A. Sprague and J. Lanjouw are *ex officio* members of all committees. The Fungi Committee will consider proposals to modify the present International Rules of Botanical Nomenclature with respect to fungi. The new appointments were made at the International Conference on Botanical Nomenclature held at Utrecht, Holland, in June 1948.

The Royal Astronomical Society of Canada elected the following officers at its annual meeting this month: president, Andrew Thomson, Controller of the Meteorological Service of Canada; vice presidents, C. S. Beals, Dominion Astronomer, Ottawa, and J. F. Heard, David Dunlap Observatory, Richmond Hill, Ontario; general secretary, E. J. A. Kennedy, Toronto; general treasurer, J. H. Horning, Toronto; recorder, H. W. Barker, Toronto; librarian, D. W. Best, Toronto.

The Southern Section of the American Society of Plant Physiologists and the Association of Southern Agricultural Workers have elected officers for the coming year—chairman: E. M. Emmert, University of Kentucky; vice chairman: Henry C. Harris, Florida Agricultural Experiment Station, Gainesville; secretary-treasurer: G. M. Shear, Virginia Agricultural Experiment Station, Blacksburg; directors: L. L. Danielson, Virginia Truck Experiment Station, Norfolk; H. B. Sprague, Texas Agricultural Research Foundation, Renner; I. E. Miles, Mississippi State College.

The Southeastern Allergy Association elected the following officers at its recent meeting: president, Oscar Swineford, professor of medicine, University of Virginia; vice president, Oscar Hansen-Pruss, chief of Duke University's Allergy Clinic; executive committee, George F. Hieber, St. Petersburg, Florida, and Louis D. Hoppe, Jr., Atlanta, Georgia.

Deaths

William Alton Taylor, 85, retired chief of the Bureau of Plant Industry, U. S. Department of Agriculture, died February 9.

William M. White, 77, former manager and chief engineer of the hydraulics department, Allis-Chalmers Company, died at his Coral Gables, Florida home February 9.

Henry Francis Atherton, 65, former president of the Allied Chemical and Dye Corporation and member of the Chemical Advisory Committee of the Army-Navy Munitions Board, died February 10.

Louis A. Olney, 74, president of the Howe Publishing Company of New York, who had been head of the Chemistry Department, Lowell Textile Institute, for 80 years, died February 11 in Jacksonville, North Carolina. Dr. Olney and his wife, enroute to Florida at the time, both died from injuries resulting from an auto accident.

The U. S. National Commission for Unesco announces the publication of "Study Abroad," a handbook of fellowships, scholarships, and educational exchange listing over 10,500 opportunities for international study in 166 subject fields in 27 countries, including the U. S. The largest number of awards is in science, particularly medicine, public health, engineering, and chemistry. The handbook was prepared by William D. Carter, head of the Office for the Exchange of Persons, Unesco House, Paris. The aim of the publication is to increase the number and quality of candidates applying for fellowships, to suggest to prospective donors how new prospects can be developed, and to indicate possible overlapping as well as areas of oustanding need. Copies, published in English and in French, will be available at $1 from the Columbia University Press, New York 27, N. Y.

The National Registry of Rare Chemicals, 35 West 33rd Street, Chicago 16, Illinois, has submitted the following list of wanted chemicals: tribromogermane, trichlorogermane, trigermane, vaccenic acid, trimethylene sorbitol, glucooctose, gluconomose, *o*-aminoatropic acid, spinulosin, 4-hydroxyacridine, 4,5-dihydroxyacridine, stannous fluoride, homomyristicyl amine, homopiperonyl amine, carbonyl sulfide, 3-tropanone, urobilinogen, thymidine, phenolphthalein mono-β-glucuronide, titanium dichloride, cyclooctatetraene, kaempferol, 4-methoxy catechol.

Indian meteorologists will survey the western Himalayan ranges, including the 17,000-foot Bara Lacha Pass, next April to find a site for the high-altitude meteorological research station recently authorized by the Central Government. The sum of $900,000 has been appropriated for this project. According to S. K. Banerji, director-general of observatories of India, plans for improving the scope of existing observatories provide for equipping the Kodaikanal Astronomical Observatory (South India) with a modern ionosphere for studying changes on the surface of the sun. Two sensitive seismographs recently acquired from the U. S. have been installed at the Poona and Madras Observatories. Negotiations are now in progress to enlarge further the present facilities for meteorological research by establishing a field magnetic observatory 35 miles southeast of Bombay.

Past environments of reef-building organisms will be studied in a research program by Columbia University graduate students under the direction of Norman D. Newell, professor of geology at Columbia, and curator of Historical Geology and Fossil Invertebrates at the American Museum of Natural History. The project, one of the most extensive undertaken in the field of paloo-ecology, is designed to provide the first comprehensive conception of conditions under which reef-building organisms existed and the manner in which associated limestones were formed. Several years of field and laboratory study of both ancient reefs and their modern counterparts will be necessary to bring the project to completion. The reefs to be studied are those in the West Texas-Southeast New Mexico oil-producing regions and include the famous limestones in which the Carlsbad Caverns are located. These extensive deposits were constructed mainly through the agency of huge colonies of plant and animal life which existed in the seas of the Permian period. The research is being supported by the Humble Oil and Refining Company.

The Museum of Northern Arizona at Flagstaff has plans for three archaeological projects in Arizona this spring and summer, all financed by a grant from the Viking Fund. One group, under the direction of John C. McGregor, of the University of Illinois, will excavate pithouse sites near Red Butte. Another, headed by Dick Shutler, of the University of California, will explore sites of a preceramic horizon near Sedona. Fred Wendorf, Jr., of Harvard, will conduct a third party in excavating sites dating about 500 A. D. near Holbrook. Harold S. Colton, the Museum director, is in general charge of the projects.

Research and Politics

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RESEARCH, AT LEAST IN THE SCIENCES, proceeded in the 19th century more or less apart from the nation's life. If the laboratories were not exactly ivory towers, they were at least sheltered oases, far from the noise of the market place. In the European nations scientists particularly were considered a pleasant and honored asset to the community, were respected, sometimes a little ridiculed, but generally left alone. Their discoveries were accepted, sometimes admired, and, if of practical importance, taken over and used by the applied sciences. Nobody asked a scientist why he attacked a special problem. Nobody asked him what practical good could come out of his results. It was accepted as a truism that the exploration of nature, the search for laws beneath the phenomena of nature, grew from a natural longing of the human mind and represented a goal in itself which did not need further justification. This appraisal of science had a corollary, namely, that science, being solely bent upon the discovery of truth, must be free from outside interference by society and the state, although of course governed by law. When Imperial Germany, a reactionary monarchy, led by the dyed-in-the-wool Junker, Count Bismarck, adopted a new constitution in 1871, a paragraph of this constitution read: "Science and its teachings are free." There were indeed very few instances in the European countries of the 19th century—that is, in the period in which the basis of modern science was laid—of interference with the freedom of science by governments, however reactionary, though there have always been organized groups of different colors who clamored for such interference. This was true even where the universities were completely controlled by government and the professors were civil servants. It happened, to take an example, that under the rule of the Catholic Centrist party in Bavaria, professors were denounced in the Diet for teaching evolution. But they were not prevented from continuing to do so, since even the worst reactionaries did not go so far as to abolish the freedom of teaching.

In our country, conditions were somewhat different. The Constitution does guarantee the freedom of speech, but science and its teaching are not mentioned. There are no federal universities. In endowed universities, only public opinion can prevent the trustees from setting up rules infringing upon the freedom of science. In state universities the regents, the governors, and the assemblies may, if public opinion permits, strangle the freedom of science and its teaching. Everybody knows that such things have happened. There are still states in which the teaching of evolution is forbidden. There are events happening from time to time in this or that university which force the watchdogs of liberty to boycott the offending school. But greatly to the credit of our democracy, these are rare exceptions and as a whole science and its teaching have remained free.

Does this mean that no future danger exists and that we may as well forget the problem of freedom of science? Twenty years ago such complacency would not have been too harmful. But since then the situation has been completely changed. First, we have seen the rise of dictatorships (and unfortunately thus far only two have fallen)—dictatorships which attempt to control not only the minds of their subjects but also to control what science is permitted to do and to think. Do not say this cannot happen here. It *will* not happen, I trust, but it *can* happen. Second, the applications of science to the industrial field and consequently to national defense have reached a level at which restrictions to science in some fields cannot in the general interest be avoided. This creates the problem of how to take unavoidable measures of caution without infringing upon the basic freedom of science. Third, even in the oldest and most solidly founded democracies an economy has developed which is dependent upon and interlaced with the economies of the entire world. Disappearance of distances has begun to work against traditional individualism and in favor of stronger centralization of power. Whether we like it or not, the trend everywhere is away from individualism and uncontrolled economy toward collectivism. Whether we like it or not, this tendency is bound to increase. Stronger central power means centralized control of the purse strings. This increases the danger of political control of how the money is spent. Where there are federal or state allotments to science, the control will certainly not be in the hands of the scientists. Fourth, events in science have taken place which lead more and more to the introduction of organized teamwork in research. The step from there to planned control and then control by the politicians of science is a very small one indeed. I propose to discuss mainly the first and the last of the four developments I have enumerated.

The experience of science in dictatorships is of greater significance to us than we might think. Even if there is no danger in the near future that similar tragic developments could happen here, it is instructive and important to see the pattern from which such things form and develop. You all know how the Nazis abused the science of genetics to further their criminal racial doctrines and how they made anthropology and eugenics, ethnology, and prehistory and even history in Germany a perversion and abomination. But these are things of the past—are they really?—and therefore I prefer to put in the foreground what is happening today in Soviet biology.

The whole story, part of which I had an opportunity to witness, is very remarkable.

Up to the end of the first World War genetics was practically nonexistent in Russia, though Russian biology was on a very high level. It was H. J. Muller who brought the first *Drosophila* stocks to USSR. Calvin F. Bridges soon afterwards served as a professor of genetics in Leningrad. Russian biologists took to the new science with enthusiasm and soon centers of research sprang up in which excellent work was done. In fundamental genetics it was first the zoologist, my late friend Philipchenko, who organized a fine group center in animal and plant genetics and did important work himself. The second great center developed in Moscow where Russia's leading zoologist of that time, the great scholar, observer, experimentalist, and thinker, N. K. Koltzoff (one of my oldest friends), realized the overwhelming importance of the new science and organized genetical and cytological departments in his laboratory of experimental biology. These leaders were followed by a host of excellent men and one has only to look at the volumes of the *Biological Journal* and other Soviet periodicals of the time between 1920 and 1930 to witness the brilliant upsurge of genetical and cytogenetical work in USSR. Parallel with this development went an enthusiastic realization of the importance of genetics for plant and animal breeding. Here the recognized leader was Vavilov. Though originally trained as a geneticist, he never did any outstanding work in fundamental genetics. His interest was in the application of genetical work to plant breeding. Thus, he devoted all his explosive energy to the building of an organization of modern experimental stations all over the country in which genetical and cytogenetical methods were used for the improvement of crop plants. When I visited his laboratory in 1929, he had a staff of about 2,000 employees, and the government furnished ample means for his work. His own line of thought, which earned for him leadership in his field, led to the recognition of the genic reserve available in old cultural varieties and their surviving ancestors. In a continual series of collecting expeditions he searched for such forms and brought them home to test their usefulness. This was work of a long view, and it might have led to important practical results had it been continued long enough. How much in the way of practical results it did achieve is probably known only to the agronomic specialist.

I had the pleasure of seeing all this development of genetics near its height in Russia. At Leningrad in 1929 an all-Russian genetics congress was held at which three guests of honor from abroad were present: Erwin Baur, the plant geneticist, Harry Federley, the cytogeneticist, and myself. All of us, none sympathetic to the political regime in USSR, were unanimous in praising what we saw at this congress. There were innumerable papers and lively discussions. There were huge plenary sessions, with Vavilov and Philipchenko presiding, at which Soviet politicians of the highest rank praised the work of the Russian geneticists. There was a scientific enthusiasm among the old leaders as well as among the brilliant young scientists such as none of the three guests had ever witnessed before. There was an exhibition of genetical specimens and charts which was admirable, quantitatively and qualitatively. Fundamental geneticists at that time were discussing most heatedly Serebrovsky's ideas, and applied geneticists, discussing their wheat-breeding experiments, were equally represented in the very large gathering. Inside and outside the lecture halls the meeting proceeded smoothly and in a most friendly atmosphere.

This does not mean that the political leaders of the USSR did not watch our science. Actually, I was told that studies in human inheritance were fraught with danger. One leading biologist, who in his search for the hereditary basis of genius studied the pedigree of Russia's most beloved poet, Pushkin, had mentioned correctly that the poet hailed from a family of petty nobility. This biologist got into trouble with the authorities. By chance, I saw a little more of the official attitude. One day, walking along the street with my friend Philipchenko, I saw in front of a movie house a large poster of "Salamandra" decorated with pictures of this harmless animal. My surprised question was answered by my friend with an invitation to see the film. This we did, and my friend interpreted the text. To understand the implications of this propaganda film, which was featured all over Russia, we must turn back to European biology in the first decade after the rediscovery of Mendel's laws.

The Lamarckian doctrine of the inheritance of acquired characters had been completely dropped by most biologists since the time of Weismann's piercing analysis. It had hardly any adherents, except in France, where the doctrine lingered on for a long time, and in the science of paleontology. The rise of genetics, the factual basis of which is irreconcilable with the tenets of Lamarckism, had given the coup de grâce to this doctrine.

In the first decade of the century, a young Viennese zoologist, a brilliant speaker, and clever, popular writer, Kammerer, stirred European biology with a long and voluminous series of papers in which he claimed to have found proof for the inheritance of acquired characters. Two sets of his experiments were especially exciting. In one he compared the black viviparous alpine salamander (newt) with the black-and yellow-spotted oviparous salamander of the lowlands. He claimed that by breeding the black one on yellow background and the spotted one on dark background he could transform appearance as well as reproduction from one type to the other. The new induced type was claimed to be hereditary, even to Mendelize if crossed to the original form. The second experiment was done with the midwife toad, the male of which seizes the egg strings laid by the female, winds them around his hindlegs, and carries them about until hatching time. An exception to the rule, this male is devoid of the thick pigmented thumb pads which other frog and toad males need for the standard type of copulation. Kammerer claimed that he could change the mating habits of the midwife toad to those of ordinary toads by breeding them under conditions used for other toads. Such males not only stopped "midwifery" but also developed the thumb pad and, again, this new induced character was said to be inherited and to Mendelize if crossed to the original form.

In the discussion of these claims, statements were found in Kammerer's papers which did not tally. There had not been sufficient time, according to his own records, for the generations he claimed to have bred. The explosion came when an American visitor, Noble, looked at the specimens exhibited in Kammerer's institute and found that the "induced" dark thumb pad was injected with India ink. Soon after this Kammerer, who was said to have become completely despondent, accepted an invitation to live in USSR. Nothing was heard of what he did there except that, soon after, he committed suicide.

Very likely there are few men left who knew Kammerer and who had seen his work in Vienna under his own guidance, so I should like to give you my interpretation of this much-discussed tragedy. I do not believe that Kammerer was an intentional forger. He was a very highstrung, decadent but brilliant man who spent his nights, after a day in the laboratory, composing symphonies. He was originally not a scientist, but what the Germans call an "Aquarianer," an amateur breeder of lower vertebrates. In this field he had an immense skill, and I believe that the data he presented upon the direct action of the environment are largely correct. (Some of them were actually anticipated a long time before in Weismann's laboratory by M. von Chauvin, who made the experiments for just the opposite reason.) He then conceived the idea that he could prove the inheritance of acquired characters and became so obsessed with this idea that he "improved" upon his records. I have reason to believe, from what I have seen in his laboratory, that he continued his experiments, which ended by the death of the specimens, by starting again with similar looking animals. His "Aquarianer" mind did not consider this wrong. He simply did not know what an experiment amounted to. In later years he probably became so absorbed with the necessity for proving his claims that he started inventing results or "doctoring" them. Though the actual results of all this amounted to falsification, I am not certain that he realized it and intended it. He probably was a nervous wreck in the end.

Why did the USSR invite Kammerer to take refuge there from "bourgeois persecution"? One of the strange features of the Soviet religion of dialectic materialism is that it postulates the inheritance of acquired characters as a dogma. The biologist is unable to understand this. One of the underlying ideas is probably that the masses are kept down by a bad environment and that therefore a good environment would make them equal to anyone. If this change is inherited, the future lies in inducing this hereditary improvement. But if this were true, it would follow that the old aristocracy, which had lived so long in the good environment, should be genetically supreme. Of course, one notion is as wrong as the other. Why, then, the dogma of the inheritance of acquired characters? Why can the believer in communism not assume that just as much genetic talent is found in the "suppressed masses" as in the "bourgeois" part of the population and that therefore the communist regime should pick out this talent and give it a chance to blossom? I shall never be able to understand why the latter idea should not be just as good communism as the former and why genuine communism needs the dogma of the inheritance of acquired characters.

This leads us back to the film "Salamandra," which turned out to be nothing but a propaganda film for the doctrine of the inheritance of acquired characters.

It uses the tragic figure of Kammerer, his salamanders, and mixed up with them, for the story, his midwife toads. The importance attached to the subject is revealed by the facts that none other than the then all-powerful Commissar for Education, the highly cultured and intelligent Lunacharsky, is the author of the film, that his wife plays the leading lady and that Lunacharsky, playing himself, appears in one scene. Leaving out the interwoven love story written to fit the beautiful Mme. Lunacharsky, the plot is this: In a central European University a young biologist (model Kammerer) is working. He is a great friend of the people and endowed with all the qualities of a Communist movie hero. Working with salamanders, he has succeeded in changing their color by action of the environment. One day the supreme glory is achieved; the effect is inherited. The bad man of the play, a priest, learns of this, comes to the conclusion that the discovery will spell an end to the power of the church and the privileged classes, and decides to act. He meets at night in the church (I recognized with surprise that these pictures were taken in the glorious double cathedral of Erfurt in Thuringia) with a young prince of the blood whom he had succeeded in having appointed as assistant to Kammerer. (This is obviously a typical job for a German prince!) Here in the dark sacristy the plot is hatched. The prince (or the priest?) proposes to Kammerer that he announce his glorious discovery at a formal University meeting, and the scientist gladly accepts. During the following night the priest and the prince enter Kammerer's laboratory, to which the prince has the key, since he poses as the scientist's devoted collaborator. They open the jar in which the proof specimen of salamander is kept in alcohol, and inject the specimen with ink. Then follows the scene at the University meeting. All the professors and the president appear in academic robes, the young scientist is introduced and makes a brilliant speech announcing the final proof for the inheritance of acquired characters. When the applause has ended the priest (or was it the assistant? I am quoting entirely from memory) steps up, opens the jar, takes out the salamander, and dips it into a jar of water. All the color runs out of the specimen. An immense uproar starts and Kammerer is ingloriously kicked out of the University as an imposter. Some time later, we see the poor young scholar walking the streets and begging with an experimental monkey which had followed him into misery. He is completely forgotten until one of his former Russian students arrives and tries to call on him. She succeeds in finding him, finally, completely down and out, in a miserable attic. She takes the train at once to Moscow and obtains an interview with Lunacharsky (this is the scene where he appears in person), who gives orders to save the victim of bourgeois persecution. Meanwhile, the character Kammerer has sunk so low that he decides to make an end of it. The very moment he tries to commit suicide, the Russian student returns with Lunacharsky's message and prevents him from taking his life. The last scene shows a train in which Kammerer and the Russian savior are riding east and a large streamer reads "To the land of liberty."

A young plant physiologist and agronomist also attended the congress at Leningrad. He was presumably completely ignorant of genetics but he had made a great and well-deserved reputation as an agronomist by the introduction of the method of vernalization which is said to have increased production of crops considerably. His name was Trofim Lysenko—for Russian biology the man of destiny. For some years after 1929 genetics still bloomed in Soviet Russia, especially when H. J. Muller lived there and trained a group of excellent young scientists. But soon rumors began to arise that something strange and untoward was happening in Soviet genetics. The rumors centered around the name of Lysenko. One heard of public debates taking place in which Lysenko attacked genetics as not only scientifically wrong but also not conducive to improvements in agricultural breeding. Simultaneously, he advanced claims of being able to improve plants by environmental action which is at once inherited. Heredity of acquired characters was once again the slogan. Rumors increased that Lysenko's power was in ascendency; they were borne out when Vavilov was prevented from accepting the presidency of the International Genetics Congress in Edinburgh in 1939 and when the expected Russian delegation did not turn up. (I personally think that it was a mistake to elect Vavilov president of that congress. As the honor was clearly intended to back him up in his fight against Lysenko, it appeared to be a political demonstration and as such had just the opposite effect from that intended.)

The first concrete information arrived about 10 years ago when an American monthly, *Science and Society*, published part of the speeches made in the first big debate between Lysenko and the geneticists. These speeches, pro and con, did not impress one favorably. Lysenko's statements of the theories with which he wanted to replace modern genetics sounded like confused nonsense. His antagonists did not come out with clear, simple statements of what is fact and what is interpretation in genetics. One had the uncomfortable feeling, when reading these reports, that Lysenko's opponents were already frightened and spoke cautiously, making unnecessary concessions. It soon turned out that they had reason to be frightened when Vavilov was deposed and died mysteriously in a concentration camp during the war years, and when all work in plant breeding was taken over by Lysenko. Again one heard from time to time of Lysenko's ascendance, of the honors and titles given to him, among them that of *"Hero of the Soviet State"* and of president of the Lenin Academy of Agriculture. But there were still laboratories of genetics, though one heard that Koltzoff, not long before his death, was forbidden to do genetics work in his institute. Good publications were still appearing in genetics and cytogenetics, and some even reached us by the ordinary mails. During the last three or four years rumors came from Russia that Lysenko's star had passed its zenith and was setting. Then, suddenly last year papers all over the world reported that Lysenko had finally taken over *all* biology in the USSR, that teaching and research in genetics were forbidden, and that all those who opposed Lysenko were deprived of honors, or even jobs, or worse.

Were the rumors of Lysenko's sinking star wrong? A translation of Lysenko's speeches at the decisive meeting has just been published in New York. The complete frankness of Lysenko's statements leaves no doubt about what happened. He quotes a paragraph written by Academician Zhukovsky, stating that the number of theses in genetics is decreasing and that this might be due to fear of what the Lysenkoists may plan. Lysenko counters that the real explanation is that the faculties refuse to accept theses by "geneticists" of the Lysenko school. Simultaneously, he complains that such great Russian scholars as Schmalhausen do not quote him or his worshipped god, the fruit breeder Michurin, in their books. From these and similar statements, it becomes clear that all prominent Russian biologists, geneticists or not, have the same opinion about Lysenko's "discoveries" as we have. He cannot quote in his favor a single living Soviet scientist whose performance is established in the scientific world. The rumor clearly was true that Lysenko's star was sinking in Soviet "science." But the rumor overlooked one thing: that his star was rising among the professional politicians. For both reasons, it seems that he considered the time ripe for action. If he could not win by persuasion, he would win by a coup d'état; this he carried out in the best tradition. In his speech he said suavely that nobody is prevented from working in genetics, though he does not think much of this science. Then he allowed his opponents to say what they wanted. (Thus far, I have not seen translations of their futile speeches.) Then he rose for his final remarks. He began mildly by saying that among the question slips handed to him there was one asking whether his ideas had the official stamp of the party. He answered in the affirmative. I should have liked to see the faces of the scientists who heard this completely friendly and mellow statement. Translated into plain English, it would read correctly: "To all whom it may concern: Lysenko, or else!" Thus, he took over Russian biology exactly after the political pattern established in the satellite countries, by bloodless coup d'état, and we know that the "or else" has already begun.

These last speeches give a much better appraisal of Lysenko and what he stands for and what he is now permitted to enforce than do the earlier publications which have been published in English. He appears clearly in his political roles, which have been more important for his success than his biological claims. (As a corollary one should read the almost simultaneous pronouncements of his brain-truster and *advocatus diaboli*, Prezent.) There does not seem to be any doubt that Lysenko, though a clever politician, is honest and that he believes in his queer ideas, believes in them so religiously that he is willing to impose them by the sword. First of all, he is a fundamentalist. Just as the Christian fundamentalist believes in the divine origin and truth of every word of the Bible, so Lysenko believes in every word of his gods, Marx, Lenin, Stalin, and the Russian Burbank, Michurin. He can refute every argument finally by quoting from these sources. He has set up his rules of the scientific game according to what he considers to be the tenets of dialectic materialism. His views are materialistic and therefore good. All others are decreed idealistic and therefore bad. He does not realize that atomistic classic genetics is extremely materialistic, while his own views border on mysticism. Being a fundamentalist, he simply decides what is right and what is wrong, and there is no appeal. There is also no need for him to study what he condemns, because he knows a priori that it is wrong.

Next to being a fundamentalist, Lysenko is an extremely clever lawyer, almost a shyster. It is revealing to read how he sets up first a completely wrong description of Weismann's ideas and then ridicules his version of them; or how he fights pre-Mendelian ideas as the tenets of present day Mendelism; or how he recounts some technicalities which the nongeneticist cannot understand by quoting literally from Dubinin in order to ridicule genetical work in the eyes of the agronomists and politicians; or how he says on one page that chromosomes, Mendelian segregation, etc., are all figments of the imagination and on another page that he has never doubted the facts relating to all these things; or how he seizes (Prezent does this still better) upon mystical utterances of nongeneticists, even of popular writers (Prezent quotes from the popularizer Francé, from Smuts, Bergson, Bertalanffi, for all of whose statements genetics is made responsible), to show up genetics as idealistic, which means to him, criminal.

A third part of Lysenko is his chauvinism. Nothing printed appears without mention of *Soviet* science, *Soviet* Darwinism, progressive *Soviet* scientists. The ignorant reader must believe that what Lysenko does and says is 100-percent Soviet Russian, while all his opponents are traitors, imitators of foreign ideas, even promoters of capitalism and similar crimes. He does not mind attacking a Russian scholar of the pre-Soviet group for his heresies, then setting him up on another page as a Soviet scientist, when he defends that man's priority of a good idea (which Lysenko thinks, however, to be bad). I will not insist here that the incense he burns to Stalin is of a type which one formerly knew only from Nazi writers towards Hitler. This is probably the outflow of his religious fanaticism, though it sounds like repulsive adulation. Lysenko is also an able rabble-rouser. The way he presents Dubinin's work on inversions in populations of *Drosophila* is a masterpiece of this type of oratory.

Fourthly, Lysenko is a very skillful politician who knows very well the rules of the game and how and when to act.

But now let us turn to his so-called work. Not, of course, his early physiological work on vernalization but his recent work which convinced him that he is the Allah and the Mohammed of the new Soviet biology which must supplant bourgeois biology, especially genetics, even by fire and sword where mere persuasion fails. One can probably reconstruct Lysenko's development. Being successful as a plant physiologist in improving crops by changing environmental factors and not being trained in genetics, the official governmental support of heredity of acquired characters easily impressed him and suggested a way of helping the breeders with much simpler methods than those of genetics. He found support in the works of his hero, Michurin, who had successfully produced new varieties of fruit and given his own Lamarckian interpretation. Thus, Lysenko set out to develop a Lamarckian theory of heredity and to prove it experimentally. One can consider his biological activities from three aspects: his criticism of the facts and conclusions of genetics, for which he uses the rather silly term Mendelism-Morganism; his own theoretical explanations of heredity; and his alleged proofs of his views.

Lysenko does not think much of genetics and refuses to accept such simple facts as the uniformity of F_1, the numerical rules of segregation, or the chance assortment of chromosomes in meiosis, not to speak of the more advanced facts of genetics. He approvingly quotes Michurin's words that Mendelism ". . . contradicts natural truth in nature, before which no artful structure reared out of wrongly understood phenomena can stand up" and thinks that such mumbo-jumbo settles Mendelism. (He also quotes approvingly Michurin's modest statement that Michurin bequeathes his conclusions "to naturalists of coming centuries and millenniums." (One hears Hitler's voice!) Such elementary facts as the chance assortment of chromosomes Lysenko considers to be mystical nonsense. It is not an overstatement that almost every thing he says about genetics and cytogenetics in his three major translated books and speeches exhibits a complete ignorance of the subject. How is it possible that he has never taken the trouble to see with his own eyes what thousands of students all over the world are unfailingly shown in the laboratory courses in genetics and cytology, year after year? Is this bad will or obscurantism? When I read, for example, that the most important thing for Soviet biologists to do is to read "over again and again" Michurin's works, the only answer I can find is that Lysenko does not want to know the facts which he is attacking because he is a fundamentalist believer, for whom everything is decided in advance. Someone should take the trouble to extract all his statements on modern genetics, so as to have them side by side. The collection would make a stone weep.

Lysenko's second action is the development of his own ideas. Environment is everything and the operation of the environment upon the body changes it permanently. How this comes about is repeatedly stated, e.g. "Heredity is the effect of the concentration of the action of external conditions assimilated by the organism in a series of preceding generations" or, on another page, "Heredity is the property of a living body to require definite conditions for its life and development and to respond in a definite way to various conditions"; then, concerning changes in heredity: "Changes in heredity are as a rule a result of the organism's development under external conditions which, to some extent or other, do not correspond to the natural requirements of the given organic form" or "The extent of hereditary transmission of alterations depends on the extent to which the substances of the altered section of the body join in the process which leads to the formation of reproductive sexual or vegetative cells. Once we know how the heredity of an organism is built up, we can change it in a definite direction by creating definite conditions at a definite moment in the development of an organism" and so forth *ad nauseam*. The same man who produces this mystical and empty phraseology (though it can be called by a more appropriate name) derides modern genetics, with its clear-cut verifiable facts and wonderful parallelism of experimental results with cytological facts, both easily verified by any beginner; he calls modern genetics "idealistic, mystical nonsense," and his brain-truster, Prezent, even denounces genetics as made to order for the benefit of the capitalist employers of the geneticists; and, *horribile dictu,* he believes fanatically in this evident nonsense. I repeat that not a single USSR biologist of renown, all of them probably good Communists, is willing to take seriously Lysenko's so-called biology. Lysenko had to pack the Lenin Academy with his cohorts, as he naively states in his last paper, to create an audience for his theories. As for those who do not follow him there is a sinister meaning in a list of errata appended to a German translation of his speeches. It reads: "p. 24, first ¶, instead of ". . . straight lined action of *our Soviet* Cytogeneticist-Morganists" read: "straight lined action of *our home-grown* Cytogeneticists-Morganists" (Italics mine).

Biologists, however, are interested mostly in the facts which Lysenko claims to have found in proof of the inheritance of acquired characters. One should expect Lysenko to put these facts in the foreground of his discussion when he wants to convince his fellow geneticists. Actually, reports on facts play a rather modest role in his accessible writings, and they are always presented in a vague, elusive way. In his decisive discussion of his views, just before he staged his *coup d'état,* he tells us rather vaguely, as before, that he can change hereditary winter grain rapidly and at will into hereditary summer grain simply by changing the time of planting. He must certainly be aware that no one will believe this story unless it can be shown that his experiments have been made with all the precautions, controls, and checks which a knowledge of genetics requires. But he quietly skims over this subject. Being a believer and not a critical student, he obviously expects others to believe him, without question. But no one will believe his statements before seeing exact data on experimental procedure, controls, and statistical checks. At present, it seems that Lysenko considers another line of his work to be most decisive. Following in the footsteps of Michurin, he and his school have grafted on a large scale and claim to have produced many "graft hybrids," which are supposed to show that the "juices" which flow from stock to scion and vice versa can change the scion (or stock) hereditarily into the type of the other. We can judge what he believes to be his greatest success, his star witness, because he staged a dramatic demonstration toward the end of his final remarks at the 1948 meeting mentioned above. He directly addressed the Academician Zhukovsky, who had doubted (like everybody else) the reality of the existence of vegetative hybrids, and declared in a triumphant tone that he now had the pleasure of demonstrating them. A tomato strain with full leaves and red oblong fruits was used as a stock to which a scion was grafted from a strain with pinnate leaves and yellowish white fruit. Seed was taken from fruits growing on the stock and on the scion and most behaved according to their origins. But a few plants taken from the seeds from the stock had pinnate leaves and yellow fruit. This, then, was his great result, produced dramatically at the height of his discussion. I am sure that the agronomists present were deeply impressed. But what did the geneticists think? Before Lysenko's unfounded interpretation could be discussed, one might ask, first, whether no genetical facts are known in explanation of the result, assuming that the experiment was made with genetically pure strains. It has been known ever since the classic work of Winkler and Baur that chimeras are produced in definite ways after grafting. This means that the tissues of stock and scion can grow together into a whole. It was shown further that the subepidermal layer, from which the sex cells originate, can enter such a chimera from one or the other form used. The seed then will belong to the form which furnished the subepidermal layer, as Winkler proved by the chromosome counts in his nightshade-tomato grafts. (Winkler, by the way, produced also a single real graft hybrid or burdo, not by "juices" but by vegetative union of cells, as again proved by the chromosomes.) Obviously, the pinnate, yellow-producing seeds of Lysenko were pure descendants of the scion, via subepidermal ingrowth into the stock. If this fact-founded interpretation cannot be disproved by real and decisive facts, Lysenko's top demonstration collapses. Thus far, I have not seen any hint that Lysenko was even aware of a simple genetical explanation for his results. [In his book, translated and published in 1946, Lysenko discusses chimeras (p. 57). In these paragraphs he surpasses himself in ignorance, if not actual ill will.]

It is not necessary to go on with a discussion of Lysenko's so-called factual material, when his own star-witness experiments are found wanting in every respect. To base a revolution in biology upon such material is certainly a feat of great optimism, though not of much self-criticism. *Parturiunt montes nascetur ridiculus mus.*

Pseudobiological literature of all times is full of books by philosophers, statesmen, theologians, and cranks who want to replace facts and laws found by the hard work of the active biologists with their own pet ideas or creeds. Lysenko would certainly join this group, which always finds followers among laymen, if he lived in the Western World, and his doings would remain a curiosity on a library shelf. However, his case, otherwise completely uninteresting, has become entirely significant by the fact that he has succeeded in persuading the high command of the party, including, as it seems, the dictator himself, that his, Lysenko's, line is first, truly Marxian, second, of greatest importance for the economy of his country and full of practical promise, and, third, 100 percent Soviet Russian; further, that scientific genetics is anti-Marxian, capitalist-employed, a foreign importation, wrong in fact and theory and a hindrance to agricultural progress. Thus far, this is a local Russian affair. But when, in consequence, the politicians have given him the power to destroy a whole science of greatest achievement and to persecute its exponents, a situation has developed which must awaken the entire world. We know that Communism is a creed and that its believers everywhere will follow the party line religiously. We know that in the Eastern Zone of Germany, Lysenkoism is already being introduced in the high school curriculum. We know that the red-tainted Japanese youth is already flirting with Lysenkoism and that a large scale discussion of it is going on in the Japanese press. Thus, the freedom of science is in danger everywhere, and the local affair becomes one of universal concern.

I do not want to imply that we are in danger of having a Lysenko appear in our midst. But there are different degrees of such things. This brings me back to the fourth recent development in science which I recounted in the introduction to this address, when I said that only small steps lead from organized teamwork to professional planners and finally to political control. I cannot help saying that I have followed with serious misgivings the increasing trend towards planned and organized science, though realizing its need in certain fields. Formerly, a scientist thought out or encountered a problem and started working on it. As often as not he found something in the course of the work which led him in a new direction. An occasional observation, which most others would have overlooked, led the born researcher into new fields, an unexpected flash of an idea opened new vistas and led to solutions or to more problems. All great ideas and all great discoveries in the realm of pure science have come into existence this way.

But now a man does not work on some subject or problem. He has a "project." A plan has been laid out, even worked out in all detail, a staff has been brought together and each one has been assigned his duty. An organization has approved the plan and furnished the funds; in return it expects progress reports, visible and quick results, and no deviation from the plan agreed upon. Everybody is happy to have a "project," and only Minerva covers her face and sends the owl away to catch mice.

I realize certainly that there are types of work which should be handled as organized "projects." If you want to prepare 200 stereoisomers of some organic compound and test their action as insecticides, a project is in order. If you want to eradicate a certain mosquito in a certain place, go and organize it. But how a major discovery or idea can come from a project I am unable to understand. This, however, is not what I want to discuss. I want, rather, to point to the danger to the freedom of science which lurks behind this way of making science. The danger will come from the men who are attracted to such a type of scientific big business. The thinker, the blaster of new paths, the keen observer, the man of intuition whose thinking is ahead of his time, will not flock to the big Government-financed and -sponsored projects. Sooner or later leadership will fall to the university politician, the promoter, the men who make the headlines—headlines not in the history of discovery but in the press. Second-raters will attain the power that goes with the big funds, and then the moment of danger arrives. They will favor what they like and understand, suppress what is beyond their vision. Being not too intelligent, they will fall prey to the flatterer, and will always go along with the latest scientific fashion or even the doubtful schemes of fanatics or reactionaries, and certainly always with well-entrenched schools. They will easily find the ear of the politicians who run the funds, for both talk the same language. At this point the setting is ready for a Lysenko type. Though our political system will not give him a chance to act as savagely as is possible in Russia, he could do enormous damage to the progress of science and the freedom of research if not checked in time. This sounds very pessimistic, but human nature is the same everywhere, fanatical activists are available everywhere if not kept in check, and men who believe in "politics as usual" are not only more numerous than men of original ideas but are also more selfish and ruthless. Thus, I believe that the increasing financial support of research, especially by government and political agencies, tending to flow into the channels of organized research, is fraught with the danger of bossism in science, with the danger of subsidizing mediocrity, and in the end with a threat to the freedom of science and its teaching. This is not to say that I am opposed to government funds' being set aside for fundamental research. This is a need of our time, a necessity. But precautions should be taken and a watchful eye should be kept to prevent such funds from working to the detriment of real science. It is the young generation, who will profit from the incoming funds, who should also be alerted against the danger that politicians, both those within and those outside the universities, will take over science. The young researcher must insist upon the right to think for himself, to plan for himself, to make his own mistakes, and to be happy over an unplanned, unforeseen discovery. Real progress in science has always been made and will always be made by the free mind, left to its own working under a system where science is free.

Based upon a presidential address given at a meeting of the Phi Sigma Society held December 10, 1948 at the University of New Mexico.

Age Determination by Radiocarbon Content: World-Wide Assay of Natural Radiocarbon[1]

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SOME TIME AGO THE OCCURRENCE of radiocarbon in living matter and dissolved ocean carbonate was reported (*1, 2, 4, 5*) as a result of researches on sewage methane gas from the City of Baltimore. The postulated origin (*5*)—cosmic ray neutrons reacting with atmospheric nitrogen to give radiocarbon at high altitudes—clearly predicted that all material in the life cycle and all material exchangeable with atmospheric carbon dioxide, such as carbonate dissolved in sea water, would be radioactive. The long half-life of radiocarbon, 5,720 ± 47 years (*3*), further seemed to ensure that the mixing processes would have ample time to distribute the radiocarbon uniformly throughout the world.

Since completing the first tests using isotopic enrichment with Dr. Grosse and his associates, an improvement in counting technique has enabled us to investigate materials without enrichment to about 5–10% error. The samples are counted in the form of elementary carbon in a screen wall counter (*6*). Six grams of carbon are spread uniformly over an area of 300 cm^2, to give an "infinitely thick" layer; about 5.9% of the disintegrations register in this arrangement. The background of the counter has been reduced from 150 cpm (when shielded by 2″ of lead) to 10 cpm by means of anti-coincidence shielding and the addition of a 4″ iron liner inside the lead shield. The technique will be described in detail elsewhere. A world-wide assay has been completed, and the uniformity apparently established. The data are presented in Table 1.

TABLE 1

WORLD-WIDE ASSAY OF RADIOCARBON

Sample	Assay (cpm/gm of carbon)
Baltimore sewage methane (*1, 2*)	10.5 ± 1
Ironwood from Marshall Islands	11.5 ± 0.6
" " " "	12.6 ± 1.0
Elmwood, Chicago Campus	12.7 ± 0.8
" " "	11.9 ± 0.7
Pine, Mt. Wilson, New Mexico, (10,000′ altitude)	12.5 ± 0.6
Bolivian wood	13.5 ± 0.6
" "	11.3 ± 0.8
Ceylon wood	12.5 ± 0.7
Tierra del Fuego wood	12.8 ± 0.5
Panamanian wood	13.0 ± 0.5
Palestinian wood	12.4 ± 0.4
Swedish wood	12.6 ± 0.5
New South Wales wood	13.3 ± 0.4
North African wood	11.0 ± 0.4
Weighted average	12.5 ± 0.2
Sea shell, Florida west coast	13.3 ± 0.5
" " " " "	14.9 ± 0.7
" " " " "	14.6 ± 0.5
Weighted average	14.1 ± 0.3
Seal oil, Antarctic	10.4 ± 0.7

The numbers quoted are intended to be absolute disintegration rates per gram of carbon. It must be said, however, that our absolute calibration of the counters used may have as much as 10% error. We hope to improve this in the near future. Since all the samples were measured with the same technique, the relative comparison does not involve this point. With the exception of the Antarctic seal sample, which has been run only once to date, the uniformity is well within experimental error. Since one expects the arctic samples if anything to be high, because the neutron intensity is lowest at the equator and rises towards the poles (*9*), and since the deviation of the seal oil from the mean is not much larger than the error of the measurement, it is believed that further measurements will show this sample to be normal also. The result on the sea shell sample is interesting. It has been shown (*7, 8*) that C^{13} occurs in higher abundance in carbonates than in organic material. The result we find for radiocarbon in sea shells versus wood and other organic material is in line with this earlier finding for C^{13}. It is true, however, that the difference may be somewhat larger in our case than that predicted from the earlier results, though the error of our measurement is so large at present as to well overlap the predicted value.

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[2] DuPont Fellow in Chemistry.

AGE DETERMINATION

Having established the world-wide uniformity of the radiocarbon assay at the present time, it seems a logical assumption that this would have been true in ancient times. Assuming this, and using the half-life of radiocarbon, 5,720 ± 47 years (*2*), one can calculate the specific activity to be expected after any given time interval elapsed since the removal of any carbonaceous material from equilibrium with the life cycle. For living materials this probably coincides with the time of death; for carbonates it would correspond to the time of crystallization (assuming no further interchange with the solution or atmospheric carbon dioxide to occur). On this basis we have undertaken examination of wood samples of well established age from the ancient Egyptian tombs. Two such samples were used, one from the tomb of Sneferu at Meydum (furnished by Froelich Rainey, of the University of Pennsylvania Museum, Philadelphia) which was 4,575 ± 75 years old; the other from the tomb of Zoser at Sakkara (furnished by Ambrose Lansing, of the Metropolitan Museum of New York) which was 4,650 ± 75 years old. The former sample is cypress wood; the latter is acacia. John Wilson, of the Oriental Institute of the University of Chicago, has given the dates quoted, at the behest of a committee of the American Anthropological Association, consisting of Frederick Johnson, chairman, Froelich Rainey, and Donald Collier. The expected assay for 4,600-year material is easily calculated to be 7.15 ± 0.15 cpm/gm of carbon on the basis of the present assay and the half-life. Table 2 presents the data obtained on these materials.

TABLE 2

AGE DETERMINATION ON THE ANCIENT EGYPTIAN SAMPLES

Sample	Specific activity found (cpm/gm of carbon)
Zoser	7.88 ± 0.74
"	7.36 ± 0.53
Sneferu	6.95 ± 0.40
"	7.42 ± 0.38
"	6.26 ± 0.41
Weighted average (both samples)	7.04 ± 0.20
Expected value	7.15 ± 0.15

The data on both samples were averaged since the error in ages almost overlaps the difference, and the weighting was taken according to the error quoted in each run. The errors quoted here and in Table 1 also are standard deviations determined strictly from the statistical counting error, and, since the data agree within these errors, we believe that no other appreciable error is involved in the measurement. It is gratifying that the mean of the determinations agrees with the expected value within 1 standard deviation unit. An error of 0.4 cpm/gm in the specific activity corresponds to an error of 450 years in a 4,600-year-old sample.

On this basis we feel encouraged to proceed with further tests on younger samples of known age. This work is now in progress. It is hoped that certain unknowns can be measured in the near future. A large thermal diffusion column similar to the one used by Dr. Grosse and his associates has been installed in the laboratory and a considerable increase in accuracy should result, permitting the measurement of samples as old as 20,000 to 25,000 years.

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TECHNICAL PAPERS

1-C^{14}-D-Glucose and 1-C^{14}-D-Mannose

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Radioactive C^{14} was first incorporated in the hexose molecule by allowing green plants to assimilate $C^{14}O_2$ (*2*). The resulting glucose contained C^{14} in all positions of the carbon chain, with the highest concentration of the radioactivity in carbons 3 and 4 (*1*). Starch labeled with isotopic C^{13} also has been prepared by growing plants in an atmosphere of $C^{13}O_2$ (*3*).

Previously, glycogen containing isotopic C^{11} had been produced by injecting $NaHC^{11}O_3$ into rats being fed nonradioactive sodium lactate (*7*). Evidence was subsequently obtained, using C^{14}, that the biosynthetic glucose comprising the glycogen was labeled only in carbons 3 and 4 (*9*). This synthesis of labeled glucose has recently been employed with $NaHC^{14}O_3$ (*10*).

For studies of the fate of hexose in experiments that involve fragmentation of the molecule, the need was apparent for a glucose containing C^{14} in only one known position of the carbon chain, preferably in the reactive reducing group of carbon 1.

D-Glucose and D-mannose labeled with C^{14} in the aldehyde carbon have now been prepared in the crystalline state by application of the nitromethane synthesis (*8*) to D-arabinose.

Sixteen grams of C^{14}-methanol containing 4 mc of radioactivity was converted to 60 gm of methyl iodide by the method of Norris (*6*). By application of the Victor Meyer reaction (*4*) with silver nitrite, the methyl iodide yielded 18 gm of nitromethane and 4 gm of the isomeric methyl nitrite. Condensation of the nitromethane with D-arabinose yielded, after separation and purification, 11.0 gm of 1-nitro-1-desoxy-D-mannitol and 6.0 gm of 1-nitro-1-desoxy-D-glucitol. Conversion of the respective nitroalcohols to the corresponding hexoses by the Nef reaction (*5*, *8*) gave D-mannose phenylhydrazone in 80% yield and crystalline D-glucose in 60% yield. Crystalline D-mannose was obtained from the phenyl hydrazone in 90% yield by cleavage with benzaldehyde.

The sugars, whose calculated specific activity is .044 µc/mg showed an observed activity of approximately 62,000 cpm/mg when counted from a thin layer in the R.C.L.-Nucleometer.[1]

Experimental details will be published elsewhere.

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Crushing Strengths of Minerals at Low Temperatures

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An attempt was made to measure and evaluate the effects of subnormal temperatures on the crushing strengths of several available common minerals (prochlorite, serpentine, graphite, selenite, and halite).

In all cases except that of halite, cylindrical samples 0.4″ in diameter were cut from mineral masses by means of a milled hollow tool. Ends of the samples were squared and polished on a lapping wheel to ensure equal distribution of the pressure applied. All halite samples were nearly perfect cubes cleaved from a single mass.

The apparatus used to produce and measure the force applied consisted essentially of a hydraulic jack with a registering pressure gauge attached. Containers fashioned of sheet aluminum, asbestos insulated, permitted cooling of the test samples in place. Dry ice and liquid oxygen were used as refrigerating agents, tests being made at room temperature, − 78.7° C, and − 183° C.

Pressure was applied at opposite ends of the samples, normal to the planes of cleavage when cleavage was present. Since halite cleaves in three planes at right angles, two planes of cleavage therefore lay parallel to the direction of force.

Graphite exhibited a decelerating increase in crushing strength with decrease in temperature, while prochlorite, serpentine, and selenite showed an accelerating increase. Halite, contrary to the others, showed an accelerating *decrease* in crushing strength with decrease in temperature. (The crushing strength of halite dropped from 11,850 PPSI to 8,250 PPSI with a decrease in temperature from 25° C to − 183° C.)

Since halite presented two planes of cleavage parallel to the direction of pressure applied, it is probable that in this case the results involved not only a change in crushing strength but an increased ease of cleaving with lowered temperature.

The changes in crushing strength with temperature change from 25° C to $-183°$ C were as follows: serpentine, $+517\%$; prochlorite, $+227\%$; selenite, $+129\%$; graphite, $+104\%$; and halite, -72%.

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A Microscope Stage for Continuous Anesthesia of Insects

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Williams (*1*) described a method of continuous anesthesia for insects using carbon dioxide with a Buchner funnel as the anesthetizing cell, the insects being placed in the open depression of the funnel. The Buchner funnel must be mounted flush in the top of a table or used with a microscope having an elevated stage with the funnel fitted to a metal plate which is substituted for the glass stage.

Work in this laboratory requires that small insects such as clothes moths, flour beetles, and mosquitoes be held under continuous anesthesia during experimental manipulation. When operating on small insects, a shallow stage in which the sides of the anesthetizing cell do not interfere with the dissecting instruments is preferred. It is also desirable that the microscope with the stage in place be readily moved to any table for use without an elevated stage. The anesthetizing stage shown in Fig. 1 was designed for use with a Spencer stereoscopic microscope; however, the device can be adapted for use with any similar type of microscope.

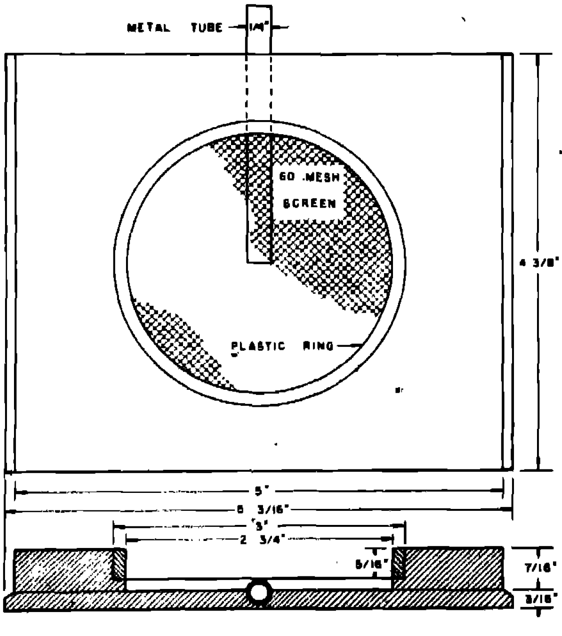

FIG. 1. Plan and cross section drawings of anesthetizing stage.

The stage is made from two plates with the cell cut in the upper plate (see cross section in Fig. 1). The wider lower plate that forms the bottom of the cell slides into the base of the microscope. A hole is drilled between the two plates to receive a metal tube connection for carbon dioxide. The connection opens into the center of the cell in the space between the bottom plate and the screen above. A shoulder is machined around the periphery of the cell opening in the upper plate, against which a disc of 60-mesh screen is held by a tightly fitting plastic ring. If deeper cells are needed for use with larger insects, the height can be increased by using plastic rings which will project as far as necessary above the plate. Steel was used for the plates that form the stage, although aluminum or plastic would have the advantages of lightness and resistance to corrosion from perspiration. The diameter of the cell is larger than the field of the microscope at the lowest magnification; for use at higher magnifications the cell diameter might advantageously be reduced. The stage in place in the microscope is shown in Fig. 2.

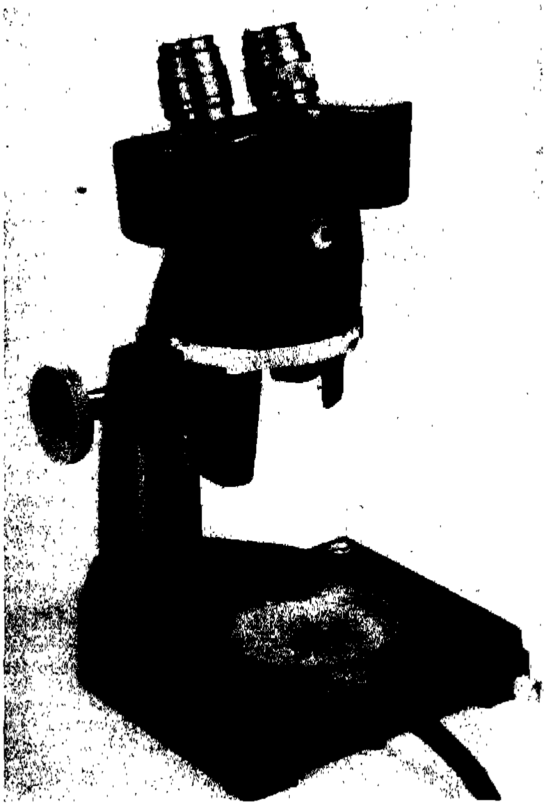

FIG. 2. Anesthetizing stage in position in dissecting microscope.

This stage permits convenient experimental micrurgy of small insects under continuous carbon dioxide anesthesia. It eliminates the Buchner funnel, which has been used previously, and has the advantages of not requiring a permanent mounting in a table or the use of an elevated stage for the microscope.

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Changes in Bark Thickness During Sap Flow in Sugar Maples[1]

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The phenomenon of sap flow in sugar maple, *Acer saccharophorum* Koch (*Acer saccharum* Marsh), and other species has been the subject of investigation for many years (*4, 7, 6, 3*). Burstrom and Krogh (*1*) have added valuable observations on *Carpinus*.

TABLE 1

Date	Time		Exp. 1		Exp. 2		
		Air temp. (°C)	Changes in bark thickness (μ) Avg. 14 trees	Xylem temp. (°C)	Changes in bark thickness (μ) Avg. 2 trees	Changes in xylem diameter (μ) Avg. 2 trees	Change in 10 mm of xylem diameter (μ) Avg. 2 trees
4/3	10 : 30 a.m.	− 8		+ 7			
					+ 30	− 64	− 1.39
	8 : 15 p.m.	− 3		+ 4			
			− 63		− 86	− 16	− .35
4/4	5 : 45 a.m.	− 6		− 1			
			+ 72		+ 62	+ 55	+ 1.20
	12 : 15 p.m.	+ 7		+ 1			
			− 8		+ 7	+ 11	+ .24
4/5	6 : 00 a.m.	+ 8		+ 2			
			− 9		− 6	+ 2	+ .04
	1 : 40 p.m.	+ 19		+ 6			
			+ 8		+ 6	− 37	− .80
4/6	4 : 45 p.m.	+ 12		+ 11			
			− 1		+ 5	− 7	− .15
4/7	6 : 00 a.m.	+ 2		+ 10			
			− 2		− 16	+ 36	+ .78
	3 : 45 p.m.	+ 15		+ 9			
			+ 4		+ 5	+ 1	+ .02
4/8	3 : 15 p.m.	+ 14		+ 11			
			+ 1		− 5	− 6	− .13
4/9	2 : 45 p.m.	− 2		+ 9			
			− 83		− 67	− 20	− .43
4/10	5 : 45 a.m.	− 8		+ 5			
			+ 80		+ 69	+ 36	+ .78
	2 : 45 p.m.	+ 2		+ 3			
			− 48		− 40	− 26	− .56
4/11	6 : 00 a.m.	− 2		+ 3			
			+ 48		+ 85	+ 31	+ .67
	12 : 00 noon	+ 4		+ 2			
			+ 25		+ 52	+ 5	+ .11
4/12	9 : 00 a.m.	+ 11		+ 5			
			± 0		− 21	− 16	− .35
	5 : 00 p.m.	+ 12		+ 6			
			− 1		− 9	− 9	− .20
4/13	2 : 00 p.m.	+ 11		+ 7			

No completely satisfactory explanation of the mechanism responsible for the transitory xylem pressure and sap flow has been suggested. Stevens and Eggert show that excised red maple stems when supplied with water and allowed to freeze and thaw in nature produce a flow of sap, which demonstrates that roots are not essential for a xylem pressure. They also suggest that xylem pressures are the result of the change in state from ice to a liquid solution of the vessel sap. Johnson is of the opinion that respiration rate changes produce the pressure and that oxygen tension in the tissues is of great importance. Burstrom regards an osmotic mechanism involving the living cells in the xylem and the contents of the xylem vessels as the best explanation for bleeding in *Carpinus*. Wiegand, in a theoretical exposition three decades earlier, considered several possible mechanisms. He concluded that, as a result of temperature changes in the stem, an osmotic gradient occurred between the contents of the xylem vessels and the adjacent living cells. Thus, water or a solution moved into the vessels and created a pressure.

In experiments designed to study the tissues that are active in the flow mechanism, it was found that when the tissues exterior to the xylem were removed no flow occurred. To investigate the physical changes in the bark, further studies were made in the field on mature trees during the spring of 1948. The results of these field observations are reported here.

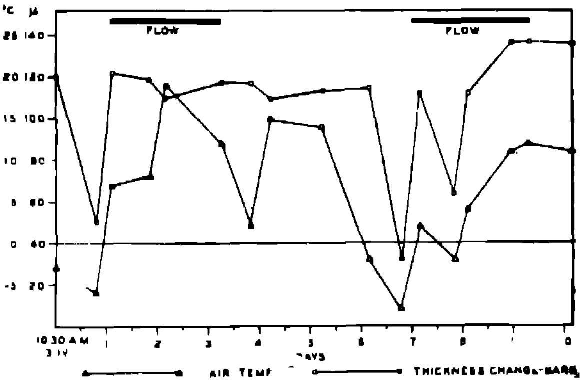

FIG. 1. Air temperatures and the changes in bark thickness. The changes are the average for the 14 trees measured.

Air temperatures were recorded, and the changes in bark thickness measured with a micrometer during and between periods of flow after the technique of Beineke (*5*) and Daubenmire (*2*). Screws were inserted into the wood through holes in the bark and measurements were made between the heads of the screws and the surface of the bark; in this way changes in bark thickness rather than the bark thickness were recorded. These observations were made four feet above the ground on nearly mature trees. Changes in air temperature affected the micrometer and corrections were then made for these changes. Table 1 (experiment 1) and Fig. 1 show the changes in bark thickness which occurred between two successive measurements of 14 trees during two freezing periods and for the four-day period of high temperatures between freezes. During the cooling and freezing part of the diurnal temperature cycle as observed in the field, the bark decreased in thickness. A warm temperature following the freeze was accompanied by a rapid increase in bark thickness of about the same magnitude as the previous decrease. For example, between 2:45 p.m., April 9, and 5:45 a.m., April 10, a freeze occurred, and the difference between the readings of the bark thickness for those two observations was − 83 µ. Between 5:45 a.m., and 2:45 p.m. April 10 a thaw occurred, and the bark increased + 80 µ. During the flow period there was some decrease in bark thickness. Changes also occurred during the period of elevated temperatures, but none of great magnitude occurred until the stem again froze.

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[1] Published with the permission of the Director of the Vermont Agricultural Experiment Station.

To correlate changes in bark thickness with those in the xylem, changes in the diameter of the xylem cylinder were measured. A hole was drilled through the stem and an invar steel rod of a length equal to the tree's diameter was placed in the hole. The rod was fastened to the xylem on one side of the tree and the measurements were made between the end of the rod and the surface of the xylem cylinder on the other side of the tree. Corrections were made for thermal changes in the length of the rod. The observed changes in bark thickness, wood thickness, and wood temperature are illustrated in the table (experiment 2) Fig. 2. The changes observed are comparable to those found in experiment 1.

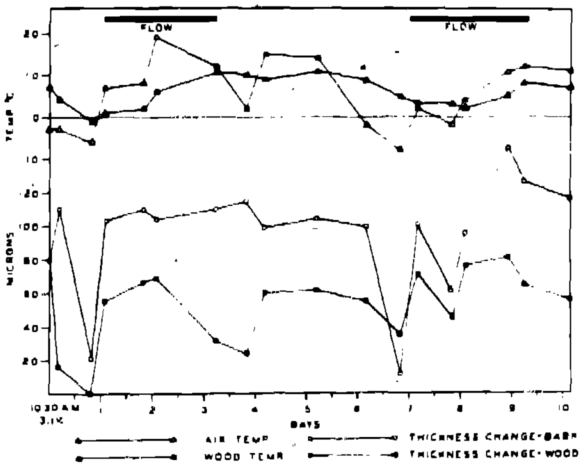

FIG. 2. The lower graph illustrates the changes in thickness of the bark and the xylem cylinder for the 2 trees measured. The upper graph illustrates air temperature and wood temperature for the same period.

The xylem cylinder also changed in diameter at the time the changes occurred in the bark, and the change was in the same direction as that observed for the bark (see experiment 2). The magnitude of the change in the xylem is quite different from that of the bark. The bark changes were measured for a thickness of about 1 cm; the changes for the xylem, for a xylem cylinder 46 cm in diameter. Thus, the change recorded for the wood for any period should be multiplied by .022 to compare the two tissues on a unit of thickness basis. For example, between 5:45 a.m. and 12:15 p.m. on April 4 the bark ncreased 82 µ in diameter, and the xylem cylinder 55 µ diameter. However, 1 cm of the xylem diameter in- sed only 1.20 µ; thus, the change recorded for the wood per unit of thickness was much less than that of the bark. A detailed analysis of the factors responsible for these changes is in progress.

The present observations which show that flow is preceded by a transient decrease in bark thickness induced by a transient freezing ambient temperature indicates that the bark must at least be considered in a discussion of the mechanism of sap flow.

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The Effect of Water Diuresis on Renal Plasma Flow[1]

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The effect of water diuresis on renal plasma flow in the human being has never been clearly defined. The subject has, however, been studied in various laboratory animals. Dicker and Heller (*3*), working with rats and rabbits, found that in the former species water diuresis had little or no effect on glomerular filtration rate or renal plasma flow; in the latter species both clearances rose as urine flow increased. The authors did not extend their studies to the human subject.

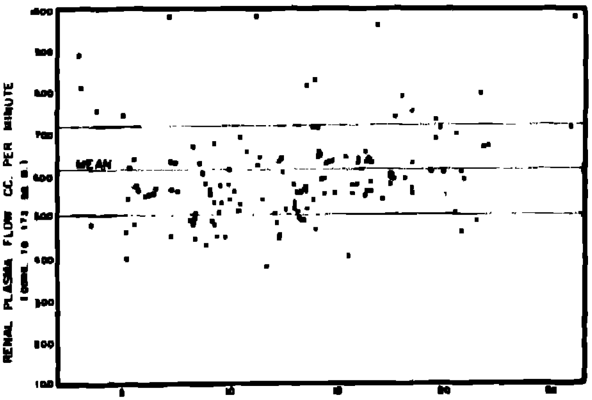

FIG. 1. Renal plasma flow at various rates of urine flow. Each dot represents a separate clearance period.

In devising a technique for the study of renal plasma flow in the human subject during exercise (*1*) we found it desirable to institute moderate water diuresis in order

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[1] This research was aided by the Research Grants Division, U. S. Public Health Service.

to overcome the antidiuretic effect of exercise. Since water diuresis, itself a stress of a sort, might conceivably affect renal plasma flow in the human subject, it was necessary to obtain specific information on the point.

Full details of the method have been reported elsewhere (*1*). Renal plasma flow was determined under basal conditions in 9 normal young men by the *p*-aminohippurate clearance technique. There was a total of 59 experiments and 140 basal clearance periods. Water was given by mouth in varying amounts before and during the clearance determinations. Urine samples were collected by voluntary micturition.

Fig. 1 shows that there is no significant trend in renal plasma flow at rates of urine flow varying from 5 to 20 cc/min. Renal plasma flow at lower rates of urine flow were not studied, but the mean figure obtained in the present work (613 ± 107 cc) is not significantly different from that obtained by other workers (*2, 4*) employing low rates of urine flow. This suggests that neither moderate water diuresis nor substitution of voluntary micturition for catheterization affects renal plasma flow in healthy young men.

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Acid Phosphomonesterase Activity of Human Neoplastic Tissue[1]

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Massachusetts Memorial Hospitals, and
Department of Medicine,
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Since the development of a method of histological demonstration of enzymes hydrolyzing mono-phosphate esters in acid hydrogen ion concentrations (*3*), it has been shown that the nuclei of cells of almost all human tissues react strongly (*10*). Neurones and prostatic epithelium alone exhibit heavy cytoplasmic staining (*1, 2, 10*). In most of this work, however, the deleterious effects of protein denaturation during fixation and heating for paraffin embedding have been ignored, resulting in inconstant staining and variable localization of the precipitate forming during incubation. In developing our method for simultaneous quantitative estimation of activity of this enzyme along with its cytological localization, we noted, as did others (*1, 8*), these factors which are to be avoided in precise work. In addition we have attempted to preserve cellular integrity to a greater extent than that usually attained in biochemical methods used in the past to measure tissue phosphatases (*11*).

Utilizing the procedures outlined below we have been able to obtain reproducible measurements of activity of this universal nuclear component of human tissues on specimens no larger than those obtained in the usual surgical biopsy. We have found that it appears definitely related to rate of tissue growth and secretion. Moreover, human cancers exhibit a uniform increase in nuclear acid phosphatase when compared with homologous tissues of origin.

FIG. 1. Advancing margin of carcinoma of stomach, stained for acid phosphatase after 30-min incubation. Central area of normal muscularis with infiltrating tumor on each side. The black areas indicate lead sulfide precipitate within nuclei, at the site of maximum phosphatase activity. The cytoplasm has been lightly counterstained with fast green. (400 ×).

The methods used have been as follows: small blocks of tissue 1–2 cm in length and a few mm wide and thick are removed from freshly obtained surgical specimens, usually adjacent to blocks obtained for pathological diagnosis. Normal gastrointestinal epithelium for control studies in gastrointestinal cancers is dissected free from the muscularis. In the case of fibroids, blocks from the central but nondegenerated part of the fibroid are removed for comparison with adjacent blocks of homogeneous and grossly uninvolved myometrium. In malignant tumors it is always a problem to obtain a block which will be rich in viable cancer tissue, approaching the epithelium of origin in density of cells. We have usually sampled the

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[1] This research was assisted in part by Cancer Teaching Grant CT-618 from the U. S. Public Health Service.

[2] Present address: Department of Virus and Rickettsial Diseases, Army Medical School, Washington, D. C.

edge of the advancing tumor, at times including a thin margin of uninvolved normal tissue (Fig. 1). We have learned to avoid the sclerotic base of many cancers which are relatively poor in malignant cells, and have had best results with sampling the soft fungating surface of polypoid lesions when such are available.

The unfixed tissue specimens may be quickly frozen in serology tubes immersed in a mixture of dry ice and acetone, and then stored in a dry ice chest without marked decline in activity. At the time of test they are thawed and sections are cut at 20–30 μ on a freezing microtome. Four to twelve such sections are then incubated at 37° C in 6–8 ml of buffered substrate for periods of 15 to 60 min, at the end of which time phosphate analyses of filtered supernatant solution are carried out by Fiske and Subbarow's method. Duplicate sections are stained for phosphatase activity after the procedure devised by Gomori (*3*) and with hematoxylin and eosin. We have used 0.01 molar sodium glycerophosphate (52% alpha)[1] for the substrate in all our tests, buffered at a pH of 5.0 + 0.1 with acetate buffer. We have found that 0.060 molar sodium acetate buffer gives best results for histological studies, but have preferred 0.162 molar buffer for quantitative microchemical analysis. We have reason to believe this preserves cellular integrity to a greater extent. We have used 0.0022 molar lead acetate in the incubating solution to precipitate the hydrolyzed phosphate for cytochemical localization; in this case the sections are not fixed on slides until after complete conversion of the precipitate to lead sulfide has been obtained. The only

TABLE 1

QUANTITATIVE ACID PHOSPHATASE ACTIVITY OF HUMAN NEOPLASMS COMPARED WITH TISSUES OF ORIGIN*

Source of tissue	Normal			Benign tumors Qap	Carcinoma Qap	Ratio
	Qap whole tissue	Qap smooth muscle	Qap epithelium or mucosa			
Stomach, ileum, colon, and rectum (mean of 10 cases)		.020 ± .009	.093 ± .034			4.7 ± 2.1
Uterine myometrium compared with leiomyomata (mean of 7 cases)		.018 ± .008		.012 ± .008		0.69 ± 0.21
Breast (not including skin)	.002				.008	4.0
	.029				.398	14
	.004				.073	18
Bronchus	.024				.214	8.9
	.060				.077	1.2†
	.022				.040	1.8
	.017				.051	3.0
Skin	.010				.066	6.6
	.029				.102	3.5
	.016				.028	1.8
Bladder	.009				.046	5.1
Esophagus	.012				.106	8.8
Stomach	.013				.030	2.3
						mean = 6.1 ± 4.6
Stomach, colon, and rectum			.066		.104	1.6
			.083		.193	2.3
			.084		.210	2.5
			.030		.027	.90‡
			.175		.287	1.6
			.018		.034	1.9
			.078		.173	2.2
			.067		.167	2.5
			.038		.067	1.8
			.081		.140	1.7
			.071		.119	1.7
			.054		.072	1.3
			.152		.192	1.3
						mean = 1.8 ± 0.5

* Each pair of values represents a different consecutive case; ± indicates standard deviation of observations from mean.
† Nitrogen mustard injected into pulmonary artery of isolated lung just prior to resection.
‡ Estimated proportion of neoplastic cells in tumor block only 52%.

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[1] Obtained from Eastman Kodak Company.

counterstain used for the latter was a 2% solution of fast green in 70% alcohol, after fixation. All quantitative microchemical enzyme studies have made use of control preparations inhibited with 0.01 molar sodium fluoride, whose free phosphate content is subtracted from that of the test preparations. The net milligrams of phosphate hydrolyzed per hour has been divided by the milligrams of total tissue nitrogen in the sections separated from supernatant by centrifugation, as determined by the micro-Kjeldahl method of Wong. All our results are expressed in terms of this quotient (Qap), which usually reflects a nitrogen content of 0.1–0.4 mg.

Preliminary studies indicate a broad optimum pH range between 4.0 and 6.0, in which enzyme activity is roughly constant; the reaction increases with time of incubation and concentration of substrate, and does not seem markedly changed by small variations in concentration of the buffer. Heat denaturation at 100° C totally abolishes the reaction. We have worked with rather low substrate concentrations and short incubation periods (15–30 min) in the cytochemical preparations to preserve the nuclear localization of lead sulfide. The initial precipitate may become diffuse within or without the cell if the cells are damaged with heat or fixatives, or if incubation is prolonged.

The nuclei of all cells except prostatic epithelium and neurones react first in stained preparations, acquiring a dense brown precipitate of lead sulfide by the time a few scattered granules of precipitate appear in the cytoplasm. Staining appears selectively to demonstrate epithelium of all types before a reaction becomes marked in supporting muscular and connective tissue elements. The columnar duct epithelium of the breast, endometrium, epidermis, mucosa of the respiratory tract, and gastrointestinal tract all display a characteristic rapid response with gross staining possible after 15–30 minutes' incubation. We have noted even greater response in specimens of thyroid, parathyroid chief cell adenoma, pheochromocytoma, and ovarian corpora lutea. Quantitative analyses of the content of enzyme in the gastrointestinal tract confirm the staining technic in revealing a fivefold increase of enzyme in mucosa as compared with homologous smooth muscle (Table 1). Prostatic tissue, however, usually has a quotient of unity or above.

Gomori observed unusually heavy staining reaction in a number of cancers (*3*), and our studies to date, which include carcinomata of the breast, lung, skin, bladder, and all portions of the gastrointestinal tract, have shown a characteristic increase in acid phosphomonoesterase activity in the tumors when compared with their tissue of origin (Table 1). Analyses of different portions of the same gastrointestinal cancer have indicated that the ratio of phosphatase activity of the tumor specimen to that of the homologous muscle-free mucosa in the control is directly proportional to the percentage of neoplastic cells in each of the former specimens.

There is a considerable variation in the proportion of neoplastic cells in the tumor samples in Table 1. In those tests utilizing glandular epithelium free of muscle, the best control yet devised, the histological preparations must indicate nearly 100% viable neoplastic cells. If this condition is satisfied, then a mean twofold increase in enzyme activity has been demonstrated in all tests thus far. Certain histologically benign colonic polyps, which could be regarded as definitely premalignant by reason of close association with polyposis coli and adenocarcinoma, showed a fourfold increase in acid phosphatase. In contrast, we have thus far been unable to find any phosphatase increase in uterine leiomyomata, due possibly to the presence of large amounts of relatively nonreactive fibrous tissue in these benign tumors. Although Greenstein has noted similar increased acid phosphatase activity in rat and mouse hepatomas compared with regenerating and normal liver, no significant increase was reported for other transplantable malignant mouse tumors (*4*). Huggins and others have noted a marked reduction in the acid phosphatase of neoplastic human prostatic tissue compared with that of the normal adult gland (*5*). Since normal prostatic epithelium contains very large amounts of cytoplasmic acid phosphatase which it also secretes, it seems likely that the loss of activity noted was largely the result of anaplastic changes affecting specialized secretory mechanisms in the cytoplasm. To the best of our knowledge, increase in tissue acid phosphatase activity has not been previously reported in human neoplasms, and we believe our observations are of significance in providing a further indication of fundamental enzymatic disturbance in human cancerous tissue. It may be that the increased acid phosphomonoesterase activity of human cancer cells is related to the rapid uptake and retention of labeled phosphorus by malignant tissue (*6*), and it has been shown that the nuclei of malignant cells are more active than the cytoplasm in this respect unlike normal cells (*7*). The predominant nuclear location of the enzyme in cancers of organs other than the prostate probably prevents its escape to the blood stream with the same facility as is seen in carcinoma of the latter gland. Only 2 to 19% of advanced cancers of other organs produce even slight elevations in the normal serum level of this enzyme (*9*).

Simple technics such as we have used may aid a more intensive investigation of the quantitative microchemical changes involved in the malignant transformation of epithelial tissues in primates.

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Book Reviews

Das Schrifttum der Bodenkultur. Wien, Austria: Hochschule für Bodenkultur. Jahrgang 1, Heft 1 (Mai 1948), 36 pp.; Heft 2 (Juli 1948), 48 pp.

The Hochschule für Bodenkultur, Austria's major institution for agricultural research and teaching, in Vienna, where the periodical reviewed is being compiled, has a history as long as most institutions of its kind in Europe and America. The Hochschule is fortunate in having as its chief librarian and documentalist Sigmund von Frauendorfer, well known for his long, successful service as library director of the International Institute of Agriculture in Rome. In that capacity he took full advantage of the unusual opportunity to increase and improve the cooperative bibliographical undertakings in agriculture, forestry, and the related sciences.

It is probably rather general among Austrian leaders today to look upon international cooperation as something more than a necessity imposed upon this small country, which is surrounded by a number of large and powerful neighbors. The current journal, *Phaidros* (issued by the Nationalbibliothek), for example, similarly conveys a genuine interest in bringing about intellectual as well as aesthetic and ethical agreement between various cultures. Even a general newspaper such as the *Neue Freie Presse* shows tendencies of this kind. It is certainly reassuring to see in these Austrian publications an undaunted spirit of responsibility and constructive criticism which accepts other values with dignity and share its own qualities generously.

Dr. Frauendorfer leads off with a good summary of the nature and purpose of documentation, giving special reference to agriculture and forestry. For many years he has emphasized the need for instruction in documentation methods, and we are not surprised to find it repeated. He states that excellent and thorough bibliographies are of little value unless the potential and expected users are actually benefited.

The second issue has, as its lead article, a discussion of the Austrian agricultural press since the end of World War II, followed by a detailed bibliography of the 68 journals mentioned. Dr. Frauendorfer suggests that there is room for planning in this area in order to avoid uneconomical duplication of effort where there may be two journals for hunting and two for the sawmill industry, besides special ones in the fields of forestry and lumber.

The same able and highly instructive manner of reporting and appraisal displayed in the leading articles is shown in the review section. This and the special review department for periodical publications may prove to be the most valuable part of the *Schrifttum der Bodenkultur*. The sovereign objectivity of the editor, which should assure this journal an important place in the international agricultural world, is seen in the discussion of the Hudson-Richens pamphlet, *The new genetics in the Soviet Union.*

The scope of the *Schrifttum der Bodenkultur* is comprehensive in its subject matter and cultural and language affiliations. It is to be hoped that the editor will receive effective assistance from within and without Austria in making the new journal fulfill his aspirations.

The international book exhibition, sponsored by the Hochschule für Bodenkultur during June 1948, reported in Heft 2 of the *Schrifttum*, pp. 45–46, presented good selections of recent publications from several counties. This should inspire Austrians and visitors from other countries to step forward and match the honest and sincere efforts of this little but important land.

ICKO IBEN

University of Illinois

Equazioni differenziali. F. Tricomi. (Ed.) Torino, Italy: G. Einaudi, 1948. Pp. 313. (Illustrated.) 2400 lire.

This textbook on advanced ordinary differential equations, mainly of linear type, contains the author's improvements of Bendixon's theorem on the shape of solutions, and also of a theorem by Sonin and Pólya on the conditions under which the maxima and minima of a solution of a second order linear differential equation form a steadily increasing or decreasing sequence. Great care was given to general theorems on the location of zeros of the solutions; theorems on the zeros of Bessel functions are derived from much more general ones in a very simple manner.

The study of the boundary value problems of the Sturm-Liouville type is based on an ingenious and quite elementary transformation of Prüfer which reduces the problem to a single differential equation of first order. The author discusses the behavior of the characteristic values as the differential equation changes as well as relations to integral equations. A chapter on the so-called asymptotic methods includes a brief outline of the Laguerre and Legendre polynomials and illustrates numerically how good the asymptotic approximations under appropriate conditions are. A chapter on differential equations for complex variable includes the customary topics and also methods of solution through divergent series. The book has pronounced traits of originality in the choice of topics and particularly in its manner of presentation. The latter may be exemplified by the introduction of the elliptic functions of Jacobi as an application of a classical theorem on the existence of solutions of differential equations. The clarity of exposition, good printing and appropriate drawings make this book pleasantly readable.

I. OPATOWSKI

The University of Chicago

Association Affairs

The Gordon Research Conferences, sponsored by the AAAS and formerly known as the Gibson Island Research Conferences, will be held this year from June 20 to September 2 at the Colby Junior College, New London, New Hampshire, 100 miles from Boston and 130 miles from Springfield, Massachusetts. These Conferences were established to stimulate research in universities, research foundations, and industrial laboratories. Meetings are informal, with plenty of time for informal discussions as well as scheduled lectures. They are held morning and evening Mondays through Thursdays, and on Friday mornings. Afternoons are available for recreation, reading, resting, or participation in discussion groups. This type of meeting is a valuable means of disseminating information and bringing together scientists in related fields.

The purpose of the program is not to review the known fields of chemistry but primarily to report and explore underlying theories and profitable methods of approach for making new progress. In order to protect individual rights and to promote discussion, it is an established rule of each conference that all information presented is not to be used without specific authorization of the individual making the contribution, whether in formal presentation or in discussion. No publications are prepared as emanating from the conferences.

Individuals interested in attending the conferences are requested to send in their applications to the director on or before *April 1*. Each applicant must state the institution or company with which he is connected and the type of work in which he is most interested. Attendance at each conference is limited to 100.

The director will submit the names of those requesting attendance to the conference committee for each conference. The committee will review the names and select the members in an effort to distribute the requests as widely as possible among the various institutions and companies represented. Those accepted will be notified at least five weeks prior to the date of the conference and will receive registration cards. Advance registration by mail for each conference is required. Return of the registration card with a deposit of $25.00, made payable to the Gordon Research Conferences, AAAS, completes registration. The deposit of $25.00 covers $10.00 registration fee and $15.00 credit against subsistence expenses at the college. Rates for room and meals have not yet been established but it is planned to reduce the $9.50 daily rate charged last year. Members attending a conference are expected to live at the college but if special circumstances warrant their living elsewhere they will be charged $1.00 per day toward support of the conferences. The special reduction of seventy-five cents a day to members attending at their own expense has been discontinued.

If it is necessary to cancel a reservation, notice should be sent to arrive in the office of the director three weeks prior to the conference, whereupon $20.00 will be refunded from the $25.00 deposit. No refund will be made for later cancellation.

Accommodations are available for a limited number of women to attend the conference and for wives who wish to accompany their husbands. All such requests should be made at the time of request for attendance, because these limited accommodations will be assigned in the order that specific requests are received.

Requests for attendance at the conferences, or for any additional information, should be addressed to W. George Parks, Director, Department of Chemistry, Rhode Island State College, Kingston, Rhode Island. From June 15 to September 1, 1949, mail should be addressed to Colby Junior College, New London, New Hampshire.

Program

PETROLEUM

John R. Bowman, Chairman; C. C. Price, Vice Chairman

June 20 Beveridge J. Mair, James W. Westhaver, F. D. Rossini, "Theory and Practice of Fractionation of Liquids by Adsorption"; B. H. Sage, "Hydrocarbon Thermodynamics."

June 21 F. J. McClure, "Fundamental Aspects of Modern Combustion Research"; Manson Benedict, "Use of Entropy in Chemical Engineering."

June 22 C. F. Prutton, "Petroleum Lubricant Additives"; P. Debye, "Theory and Phenomena of Micelle Formation."

June 23 M. W. Tamele, Otto Beeck, "The Nature of the Silica-Alumina Cracking Catalyst"; P. D. Foote, "Civilization's Future Energy Needs."

June 24 A. G. Oblad, T. H. Milliken, G. A. Mills, "The Active Principle of Petroleum Cracking Catalysts."

CATALYSIS

Ahlborn Wheeler, Chairman; C. W. Montgomery, Vice Chairman

***June 27* Discussion. H. S. Taylor, "The Recent Work of G. M. Schwab on the Activity of Alloy Catalysts"; John R. Bowman and Richard H. Wilhelm, "Theory and Practice in Fluid Bed Catalysis."**

***June 28* Pierce W. Selwood, "A New Technique: Nuclear Induction and the Structure of Catalytically Active Solids"; L. Hofer, "Thermo-Magnetic Analysis of Fischer-Tropsch Catalysts"; Otto Beeck, "Mechanism of (a) Isomerization and (b) Fischer-Tropsch Reactions from Experiments with Radio-Carbon and Heavy Hydrogen."**

***June 29* J. T. Kummer and P. H. Emmett, "Use of Isotopic Tracers in Chemisorption of Carbon Monoxide and Hydrogen on Iron Catalysts"; Henry H. Storch,**

''Progress Report on Process Development in Fischer-Tropsch Reaction at the U. S. Bureau of Mines''; Speaker to be announced, ''The Fischer-Tropsch Reaction in Fluid Beds.''

June 30 Symposium on Catalyst Selectivity. Ahlborn Wheeler, ''Introduction: The Influence of Reaction Kinetics and Pore Structure on Catalyst Selectivity''; John Turkevich, ''Correlation of Selectivity with the Structure of the Catalyst Surface''; K. K. Kearby and Robert P. Sieg, ''Selectivity and Reaction Mechanism in the Dehydrogenation of Butanes and Butylenes.''

July 1 L. N. Leum, ''Factors Affecting Selectivity, Activity and Life in Catalytic Cracking''; A. G. Oblad, ''Structure and Activity of Oxide Type Catalysts—A New Concept.''

ION EXCHANGE

W. C. Bauman, Chairman; Robert Kunin, Vice Chairman

July 4 W. C. Bauman, ''Cation Exchange Resins''; R. Kunin, ''Anion Exchange Resins.''

July 5 W. P. Kelley, J. S. Joffe, ''Inorganic Exchange Materials, Relation to Soils''; G. E. Boyd, E. R. Tompkins, ''Ion Exchange in the Inorganic Field.''

July 6 M. Calvin, B. N. Dickinson, H. G. Cassidy, ''Ion Exchange in the Organic Field''; L. Hammett, ''Ion Exchange Resins as Catalysts.''

July 7 H. P. Gregor, L. E. Davis, ''Static Equilibria in Ion Exchange Resins''; E. J. Roberts and H. Bliss, ''Kinetics in Batch and Continuous Operation.''

July 8 G. P. Monet, W. Juda, ''Ion Exchange as Unit Process—Economies.''

POLYMERS

R. M. Fuoss, Chairman; H. M. Spurlin, Vice Chairman

July 11 H. F. Mark, ''Polymerization and Polymer Properties in the Solid State''; P. J. Flory, ''Molecular Configuration and Intrinsic Viscosity of Polymers.''

July 12 B. H. Zimm, ''Light Scattering and the Structure of Polymers''; R. S. Spencer, ''Rheological Properties of Polymers.''

July 13 M. S. Matheson, ''Absolute Rate Constants in Free Radical Polymerizations''; K. Nozaki, ''Long-Lived Free Radicals in Polymerization Reactions''; G. E. Hulse, ''Redox Emulsion Polymerization Systems''; J. M. Swanson, ''Physical Characterization of Cellulose Xanthate in Solution.''

July 14 C. T. Walling and F. R. Mayo, ''Copolymerization by Non-Radical Mechanisms''; R. G. Heiligmann, ''Friedel-Crafts Catalyzed Polymerization at Low Temperatures''; S. G. Cohen, ''Some Reactions of Alkyl Percarbonates''; C. D. West, '' Some Molecular Interactions with Polar Polymers.''

July 15 C. A. Winkler, ''Experiments on Diffusion of High Polymers.''

TEXTILES

J. H. Dillon, Chairman; Earl E. Berkley, Vice Chairman

July 18 H. Mark, ''Principles for the Selection of Fiber-Forming Materials''; R. C. Houtz, '' 'Orlon' Acrylic Fiber: Chemistry and Properties.''

July 19 Milton Harris, ''The Nature of the Felting Phenomenon and Some Anti-Felt Treatments''; E. L. Skau, ''A Calorimetric Investigation of the Cellulose-Water Relationships in Textile Fibers.''

July 20 William Utermohlen, ''Detergency Studies''; T. E. Morton, ''Dyeing of Cellulose Considered as a Diffusion Process.''

July 21 J. W. Rowen, ''Some Infrared Studies on Cellulosic Compounds''; Joseph Brant, ''Discussion of Crease-Resistant Treatments of Fine Cotton Fabrics.''

July 22 Robert Hoffman, ''Relationship of Fiber Properties to Fabric Properties.''

CORROSION

H. R. Copson, Chairman; W. S. Loose, Vice Chairman

July 25 H. H. Uhlig, ''Theoretical Considerations Pertinent to Localized Corrosion''; Norman Hackerman, ''Effect of Condition of the Metal Surface on Localized Corrosion.''

July 26 F. L. LaQue, ''Pitting in Sea Water and Brines''; W. Lynes, ''Impingement Attack.''

July 27 E. P. Partridge, ''Pitting in Boiler Waters and Fresh Waters''; A. Wachter, ''Effects of Inhibitors on Localized Corrosion.''

July 28 A. Brenner, ''Pitting Through Coatings''; R. B. Mears, ''Granular, Transgranular, and Intergranular Corrosion.''

July 29 F. W. Fink, ''Techniques for Studying Localized Corrosion.''

INSTRUMENTATION

H. C. Frost, Chairman; V. F. Hanson, Vice Chairman

August 1 Physical Methods for Chemical Analysis. Speaker to be announced, ''Review of Recent Advances in Absorption and Emission Spectroscopy''; D. D. Friel, ''Recent Improvements of Baird Infrared Gas Analyzer''; Willard H. Bennett, ''Radio-Frequency Mass Spectrometer''; William Parrish, ''X-ray Powder Diffraction Analysis; Geiger Counter and Film Techniques.''

August 2 Measurements of Physical Properties of Materials. Shirleigh Silverman, ''Transient Gas Temperature Measurements''; Frank T. Gucker, Jr., ''Photoelectric Methods of Determining Size and other Properties of Aerosol Particles''; John W. Forrest, ''New Developments in Optical Instruments.''

August 3 Symposium on Special Instruments. This session will consist of a series of short contributions by members of the Conference. Its purpose will be to describe the application of important instruments that have been found useful for special studies but which are not known by the average laboratory worker. While it is not intended to publish the program for this session in advance, some of the subjects to be presented include: (1) Non-dispersive Ultraviolet Gas Analyzer. (2) Discussion of New Electric Circuits for Chemical Investigations. (3) Guard Circuit Bridge with Oscillograph Detector for Resistance and Capacity Measurements in the Range of 100 Cycles to 800 Kilocycles. (4) A.C. Operated Micro Micro-ammeter with Built-in Regulated

Power Supply Suitable for Recording or Indicating Phototube or Ion Chamber Currents. (5) High Sensitivity Recording Electronic Potentiometer.

August 4 Electronic Instruments and Elements for Research. J. P. Arndt, Jr., "Piezoelectricity Applied to Instrumentation"; Allen B. du Mont, "Use of Cathode-Ray Oscilloscopes in Chemical and Physical Research"; Joseph F. Lash, "A Contact Modulated Amplifier and Some of Its Laboratory Uses."

August 5 Application of Industrial-Type Instruments to Research. Speakers for this session will be announced at a later date.

VITAMINS AND METABOLISM

Esmond E. Snell, Chairman; E. L. R. Stokstad, Vice-Chairman

August 8 C. A. Baumann, "Biological Value of Certain Carotinoids"; Paul D. Boyer, "Structure and Properties of Tocopherols in Relation to Biological Function"; Roger J. Williams, "Individual Metabolic Patterns and Their Significance in Nutrition and Disease"; C. Woodruff and W. J. Darby, "The Relation of Vitamin C and Folic Acid to Tyrosine Metabolism."

August 9 Gladys Emerson and T. R. Wood, "Some Aspects of Vitamin B_{12}"; H. B. Woodruff, "Microbiological Response to Vitamin B_{12} and Substances of Related Physiological Activity"; L. D. Wright, "Microbiological Studies with Vitamin B_{12}." Discussion: William Shive. George K. Davis, "The Minor Elements, Cobalt, Copper and Molybdenum in Animal Nutrition."

August 10 George W. Kidder, Virginia C. Dewey and R. E. Parkes, Jr., "The Use of Tetrahymena in Vitamin and Metabolism Studies." Discussion: E. L. R. Stokstad. G. Fraenkel, "Insects in Vitamin Research with Special Reference to New B-Factors"; Henry Lardy, "Metabolic Functions of Biotin." Discussion: Robert E. Eakin.

August 11 William Shive, "Metabolite Antagonists and Vitamin Function"; Herschel K. Mitchell, "Neurospora Metabolism and Vitamins"; H. E. Carter, "Inositol Lipids"; I. C. Gunsalus, "Nature and Function of an Unidentified Factor Required for Pyruvate Oxidation."

August 12 John R. Murlin, "The Criteria of Biological Values Among Food Proteins." Discussion: D. V. Frost. J. B. Thiersch and F. W. Phillips, "Effect of Folic Acid Antagonists on Mammals in Reference to their Action on Neoplastic Disease."

FOOD AND NUTRITION

Daniel Melnick, Chairman; James B. Allison, Vice-Chairman

August 15 Food Acceptance. Frank R. Goetzl, "Studies on Human Appetite"; John R. Brobeck, "The Role of the Nervous System in Regulating Food Intake." Discussion: Richard H. Barnes. Theodore F. Zucker, "Appetite Depressants with Particular Reference to Gossypol"; Aaron M. Altschul, "Chemical and Physiological Investigations of Gossypol." Discussion: Edward Eagle.

August 16 Adjustment to Malnutrition. Harold H. Mitchell, "Studies with Animals"; Herbert Pollack, "Studies with Humans." Discussion: Norman Jolliffe. Henry L. Taylor, "Starvation"; Speaker to be announced, "Obesity." Discussion: L. Emmett Holt, Jr.

August 17 The Pros and Cons of Proteolysis in Food Processing and Storage. William F. Geddes, "The Milling and Baking Industry"; Orville G. Hankins, "The Meat Packing Industry." Discussion: Daniel Melnick. Newer Techniques and Controls in Preservation of Foods. Charles R. Stumbo, "Agitation of Foods during Thermal Processing"; Bernard E. Proctor, "Irradiation Procedures." Discussion: John M. Jackson.

August 18 Chromatographic Techniques. Richard J. Block, "Amino Acid Analyses"; Speaker to be announced, "Carbohydrate Analyses." Discussion. The Nutritional Implications of Vitamins with Modified Solubility Characteristics. Aaron Arnold, "Water-insoluble Forms of the Water-soluble Vitamins"; Albert E. Sobel, "Water-dispersible Forms of the Water-insoluble Vitamins." Discussion: Saul H. Rubin.

August 19 Physiological Availability of the Amino Acids. Carl N. Lyman, "Availability for Absorption"; Ernest Geiger, "The Importance of the Time Element in Supplementation." Discussion: Robert A. Harte.

MEDICINAL CHEMISTRY

R. C. Batterman, Chairman; Marlin T. Leffler, Vice-Chairman

August 22 Antihistaminics. Arthur W. Weston, "Chemistry of Antihistaminics"; Earl R. Loew, "Pharmacology and Mechanisms of Action of Antihistaminics"; Frederick Brown, "The Clinical Use of Antihistaminics in the Respiratory Allergies"; Walter C. Lobitz, Jr., "The Value of Antihistaminics to the Dermatologist."

August 23 Enzymes. Arthur Kornberg, "Enzymatic Synthesis of Dinucleotides"; Thomas P. Singer, "The Action of Riboflavin Analogues on Isolated Enzymes." Macrocytic Anemia. Karl Folkers (Tentative), "Vitamin B_{12}"; A. L. Franklin, "Nutritional Aspects of Animal Protein Factor"; Arnold D. Welch, "Present Status of Folic Acid and Vitamin B_{12}."

August 24 Chemotherapy. H. M. Crooks, Jr., "Chemistry of Chloromycetin"; Lawrence B. Hobson, "Recent Developments in Chemotherapy." Viruses. S. E. Luria, "Virus Multiplication"; Randall L. Thompson, "The Effect of Metabolite Antagonists on the Growth of Mammalian Viruses."

August 25 Rheumatoid Arthritis. Charles Ragen, "Chemistry of Rheumatoid Arthritis"; Edward F. Rosenberg, "Rheumatoid Arthritis, Present-day Aspects of Its Pathogenesis and Therapy." Diuretics. Robert A. Lehman, "Pharmacology of Mercurial Diuretics"; Robert C. Batterman, "The Clinical Evalution of Mercurial Diuretics in the Treatment of Congestive Heart Failure."

August 26 Anticoagulants. C. F. Huebner, "Chemistry of Dicumarol and Related Compounds"; M. L. Wolfrom, "The Chemistry of Heparin and Related Types of Anticoagulants''; Speaker to be announced, ''The Clinical Use of Anticoagulants.''

CANCER

W. H. Summerson, Chairman; W. U. Gardner, Vice-Chairman

August 29 O. Warburg and A. L. Lehniger, ''Cancer and Fermentation Enzymes''; G. A. LePage, ''Studies of Glycolytic Enzymes of Tumors''; J. Greenstein, ''Proteolytic Enzymes and Cancer''; D. M. Greenberg, ''Effect of Amino Acid Analogs on Protein Formation: Relation to Cancer.''

August 30 E. S. Guzman Barron, ''Mechanism of Action of Ionizing Radiations''; E. Lorenz, ''Some Biological Effects of Ionizing Radiations on Laboratory Animals''; G. O. Gey, ''Evidences of Biologic Variation in Tissue Cultured Strains of Normal and Malignant Cells''; W. Earle, ''Certain Recent Advances in Tissue Culture in Relation to Cancer Research.''

August 31 G. H. Twombly and E. F. Schoenewaldt, ''Metabolism of Estrogenic Hormones Labeled with Radioactive Isotopes''; C. R. Moore, ''Role of Hormones in the Differentiation and Determination of Tissues''; A. Cantarow and K. E. Paschkis, ''Certain Aspects of Hormone Imbalance in Experimental Carcinogenesis''; R. K. Boutwell, ''Studies on the Rate of Tumor Formation and the Activity of the Adrenal Cortex.''

September 1 F. S. Philips and J. B. Thiersch, ''Effects of 4-Amino Pteroylglutamic Acid and Congeners in Mammals''; E. B. Schoenbach, ''Status and Potentialities of Folic Acid Antagonists as Carcinolytic Agents''; S. Farber, ''Action of Folic Acid Conjugates and Antagonists on Leukemia and other Forms of Disseminated Cancer.''

September 2 J. G. Kidd and H. M. Toolan, ''Studies on the Mechanisms of Resistance and Immunity to Transplanted Cancer Cells''; J. J. Bittner, R. A. Huseby, and C. P. Barnum, Jr., ''Studies on the Factors Associated with the Development of Mammary Cancer in Mice.''

NEWS and Notes

W. C. Fernelius, chairman of the Department of Chemistry at Syracuse University, has been appointed professor and head of the Department at Penn State College, State College, Pennsylvania.

Francis E. Ray, formerly of the Laboratory of Radiochemistry, University of Cincinnati, has been appointed director of the University of Florida Cancer Research Laboratory, effective July 1.

B. I. Burns, administrator of hospitals at the University of Texas Medical Branch, Galveston, has accepted appointment as director of Municipal Hospitals for Kansas City, Missouri, effective in March.

Charles E. Lankford, formerly associate professor in Bacteriology at the University of Texas Medical School, Galveston, has been appointed associate professor in bacteriology at the main university in Austin.

Sven Hedin, 83-year old Swedish explorer and scientist who was partially blinded during an exploring expedition into Asia 55 years ago, has regained the sight of one eye through a recent operation by K. G. Ploman, Swedish eye specialist.

William G. McDaniel, chemical engineer, has joined the Operations Branch, Plants Division, Technical Command, Army Chemical Center, Maryland.

Alice Eastwood, botanist at the California Academy of Sciences since 1892 and curator of the Department of Botany since 1896, retired on January 19 on the occasion of her ninetieth birthday. At the January meeting of the Academy Council, Miss Eastwood was made curator emeritus of botany. **John Thomas Howell** was named curator, and **Elizabeth McClintock**, assistant curator.

Abel Wolman, of Johns Hopkins University, has been appointed lecturer and research consultant in Sanitary Engineering at the University of Illinois.

Margaret Fuller Boos, consultant geologist in Denver, is serving as visiting professor in the University of Illinois' Department of Geology during the spring semester.

Jaroslav Dedek, chemical engineer and former director of the research station for the sugar industry in Czechoslovakia, has taken up temporary residence in Belgium. He is interested in coming to the United States to establish an international society of beet sugar technology. Persons wishing to communicate with him may address him in care of Robert C. Hockett, 52 Wall Street, New York City 5.

Thomas K. Sherwood, dean of engineering at Massachusetts Institute of Technology, and **Bruce S. Old**, of the Arthur D. Little staff, have been elected to the Board of Directors of Arthur D. Little, Inc., Cambridge, Massachusetts.

Hyman I. Goldstein, of Camden, New Jersey, has been elected an honorary member of the Belgian Gastroenterological Society, and a corresponding member of the Cuban Society of Cancerology.

The appointment of **Harold H. Berman** as director of Willowbrook State School, Staten Island, New York City, was recently announced. Dr. Berman was formerly on the medical staff at St. Lawrence State Hospital, Ogdensburg.

Walter P. Taylor, wildlife research supervisor, U. S. Fish and Wildlife Service, and leader of the Oklahoma Cooperative Wildlife Research Unit, has been elected honorary Life Fellow of the Texas Academy of Science.

John B. Calkin, of New York City, has been appointed director of the Department of Industrial Cooperation, and associate professor of chemical engineering at the University of Maine. **Lyle Jenness**, who has been acting director of the Department will become head of the Department of Chemical Engineering.

E. D. Merrill, Arnold professor emeritus of Botany, Harvard University, has been appointed president of the Taxonomic Section of the Seventh International Botanical Congress, which is to convene in Stockholm the summer of 1950.

Harry Eagle has resigned as scientific director of the Research Branch of the National Cancer Institute, to head a new Section on Experimental Therapeutics in the Microbiological Institute, National Institutes of Health, Bethesda, Maryland.

Daniel Melnick, formerly chief of the Food Development Division, Quartermaster Food and Container Institute for the Armed Forces, has been appointed chief technologist at The Best Foods, Inc., Bayonne, New Jersey.

Paulis P. Bijlaard, Arthur J. McNair, and **Floyd O. Slate** have been appointed associate professors in the School of Civil Engineering at Cornell University.

Grants and Awards

The Robert Gould Research Foundation, Cincinnati, has made a grant-in-aid of $4,000 for research in nutrition to C. A. Elvehjem, dean of the Graduate School and chairman of the Biochemistry Department, University of Wisconsin. Dr. Elvehjem will study the use of amino acids as the sole source of protein in the diet.

On fellowships granted by the **Westinghouse Educational Foundation,** 50 secondary school teachers will receive a six-week refresher course in science at the Massachusetts Institute of Technology this summer. A total grant of $62,500 will make it possible for 50 teachers to receive grants of $250 each summer for the next five years.

The University of Cincinnati has received a $2,500 fellowship from the Crosley Broadcasting Corporation to study the relationship between education and television.

The University of Buffalo Medical School will receive $432,000 from the estate of Mrs. S. Margaret Berrick Meyer for a new research laboratory in memory of her husband. It will be known as the Edward J. Meyer Laboratory.

The Charles Hayden Foundation of Boston has created a $100,000 endowment fund at Columbia University, the income from which will be used to enable students from New York City and Boston to attend Columbia College. Since 1939, the Foundation has provided scholarship funds for more than 250 students.

The American Psychological Association has received a grant of $3,000 from the Carnegie Corporation of New York toward support of an analysis of the state of progress in each of the principal areas of psychological research.

The Photographic Society of Sweden has awarded the Adelsköld Gold Medal to C. E. K. Mees, vice president in charge of research for the Eastman Kodak Company, for his contributions to the progress of photography. Dr. Mees acknowledged the award from Rochester, New York, in a shortwave broadcast beamed to Sweden and other European countries.

The James Watt Medal of the Institution of Mechanical Engineers in London has been awarded Fredrik Ljungström, Swedish inventor, who designed the rotary air preheater.

The Kungliga Fysiografiska Sällskapet in Lund, Sweden, recently awarded its silver medal to William Randolph Taylor, University of Michigan, in recognition of his research in marine algae.

Peter J. W. Debye, of Cornell University, will receive the 1949 **Willard Gibbs Medal** at the meeting of the Chicago Section of the American Chemical Society on May 20.

The University of Southern California's Department of Chemistry has begun two new research projects, sponsored by the Office of Naval Research. Investigation of surface areas and structure of proteins will be under the supervision of Sydney W. Benson, and a study of the properties of ionic solutions at the critical temperature of the solvent under the joint supervision of Dr. Benson and Charles S. Copeland.

Richard L. Potter has been granted a postdoctorate research fellowship by the Atomic Energy commission to work with David Green in the new **Enzyme Institute** at the University of Wisconsin. The purpose of the fellowship is to provide advanced research training in the physical, biological, and medical sciences related to atomic energy. Dr. Potter will use radioactive tracers in his work on the synthesis of enzymes.

Edgar Reynolds Smith, chief of the Physical Chemistry Section, National Bureau of Standards, has been awarded the 1949 **Hillebrand prize** of the Washington Section, American Chemical Society. Dr. Smith, who prepared the first samples of heavy water, was cited particularly for his contributions to electrochemistry and ebulliometry.

Under the 1949–50 **Shell Fellowship Program,** 44 fellowships in chemistry, geology, geophysics, physics, and related fields have been established at 36 colleges and universities throughout the country. Each fellowship provides tuition and fees as well as payment of $1,200 to the student and $300 to the department of study for his expenses.

Fellowships

Butler University, Indianapolis, Indiana, announces that two new Holcomb Research Fellowships are now available to graduate students in chemistry. The fellowships are valued at $1,500 per year and are tenable for two years. Applications may be addressed to the Department of Chemistry.

The New York Zoological Society offers summer research fellowships providing $500 for three months, June 15 through September 15, to advanced research workers who hold a Ph.D. degree in physiology, zoology, biology, ecology, psychology, or a related field and who have special interest and experience in the study of animal behavior. Further information may be obtained by writing to the New York Zoological Society, **Behavior Research Program,** Bronx Zoo, New York 60, N. Y. The Society is also offering limited grants-in-aid for participation in the third

summer research program at the Jackson Hole Wildlife Park, Moran, Wyoming. Qualified graduate students and professionally established persons who wish to conduct research in ecology, conservation and land use, wildlife, life history studies, behavior, botany, ornithology, entomology, pathology and parasitology, and aquatic biology are invited to apply to program committee members: J. R. Simon, Moran, Wyoming, chairman; C. R. Carpenter, Pennsylvania State College; W. W. Chase, University of Michigan.

Colleges and Universities

An expedition from the **Instituto Lillo of Tacumán University**, Argentina, has been exploring the Tierra del Fuego-South Patagonia region for the past two months to study its zoological and geographical relationship to surrounding island groups, and to Australia and New Zealand. The expedition is headed by Claes Christian Olrog, young Swedish zoologist.

Six colleges are participating in "Project Squid," a fundamental reseach program on jet propulsion sponsored by the Office of Naval Research. Headquarters for the project are at **Princeton University**. Cooperating institutions are **New York University, Purdue University, Cornell Aeronautical Laboratory, Brooklyn Polytechnic Institute**, and the **University of Delaware**. The project will include a year's work on "Heat Transfer in Passages with Free Convection and Counter Flow," directed by S. A. Guerrieri, of the University of Delaware, with the assistance of Robert Connell and Charles V. Foster.

The University of Wisconsin has begun construction on the first $2,500,000 wing of its engineering building, the beginning of an $82,000,000 10-year building project.

The Woman's Medical College, Philadelphia, Pennsylvania has announced the following appointments to its faculty: Edward H. Vick, clinical assistant in pediatrics; William Ellis and S. Micelli, clinical assistants in urology; Harry B. Adams, Jr., clinical assistant in proctology; Mary Helen Cameron, fellow in radiology; Marian Abbott Boyd, clinical instructor in medicine; Alice M. Anderson, Frances A. Harkins, Mildred R. Mitchell, clinical assistants in medicine.

Meetings and Elections

The Texas Academy of Science elected the following officers at its December meeting in San Antonio, Texas: president, J. Brian Eby; vice president, C. M. Pomerat; editor, J. L. Baughman; president of the Conservation Council, J. G. Sinclair; secretary-treasurer, Gladys H. Baird. The theme of the meeting was "Conservation of Natural Resources and of Population." A quarterly publication, *Texas Journal of Science*, will be initiated by the Academy next month. The Collegiate and Junior Academies have a membership approaching that of the Senior Academy and each puts on a full program of its own.

The Biological Photographic Association's New York Chapter has elected Percy Brooks, head of the medical Illustration Department of Cornell University Medical School, chairman of its acting executive committee. Margaret Smith Frankow, of the Department of Dermatology, Columbia University, was elected secretary-treasurer of the group.

The Washington Academy of Sciences elected the following officers at its January meeting: president, Frank H. H. Roberts, Jr.; president-elect, Francis B. Silsbee; secretary, Frank M. Setzler; treasurer, Howard S. Rappleye; elected to the Board of Managers, William F. Foshag and C. Lewis Gazin.

The British Association for the Advancement of Science will hold its annual meeting at Newcastle-upon-Tyne, August 31–September 7. Preliminary programs will be available in early May, upon application to the secretary, David M. Lowe, BAAS, Burlington House, London W1.

The World Engineering Conference will hold its second International Technical Congress in Cairo, March 20–26. Three U. S. engineers who will present papers at the Congress are: W. H. Carson, dean of the School of Engineering, University of Oklahoma; Morris L. Cooke, Philadelphia management engineer and government consultant; and James S. Thompson, vice chairman of the board, McGraw-Hill Book Company. Max Thornburg of the Engineers Joint Council Middle East Commission has also been invited to attend as a Council delegate.

The Anthracite Conference, sponsored by the Anthracite Institute and Lehigh University, Pennsylvania, will be held at the University May 5–6. A. Copeland Callen, head of Lehigh's department of mining engineering, is chairman of the committee planning the sessions.

The International Union of Biological Sciences will hold a conference on "Development, Growth and Regeneration of the Nervous System" at the University of Chicago, March 21–25, under the chairmanship of Paul Weiss. Foreign scientists participating are J. Boeke, Utrecht; Holger Hyden, Stockholm; Rita Levi-Montalcini, Torino; Albert Stefanelli, Rome; Sydney Sunderland, Melbourne; and J. Z. Young, London.

The annual conference of the **British Textile Institute** will be held in Dublin, Ireland, May 24–27. Walter J. Hamburger, director of Fabric Research Laboratories, Inc., Boston, Massachusetts, will present a paper on "Industrial Applications of Stress-Strain Relationships."

The Midwest Power Conference, sponsored by the Illinois Institute of Technology, will be held at the Sherman Hotel, Chicago, April 18–20. Invitations are extended to those interested in the nation's power problems. Programs may be obtained from the conference secretary, Edwin R. Whitehead, Illinois Institute of Technology, 3300 Federal Street, Chicago, 16.

The American Physical Society's Division of Solid State Physics will hold a symposium in Cleveland, March 10–12. The program will include the following invited papers to be presented on Thursday afternoon and Friday morning and afternoon:

George E. Pake, Washington University, "Nuclear Magnetic Resonance in Studies of Solids"; E. Guth, University of Notre Dame (title to be announced); Charles Kittel, Bell Telephone Laboratory, "Recent Developments in Ferromagnetism''; F. S. Goucher, Bell Telephone Laboratory, ''Photoelectric Effects in PN Rectifying Barriers''; R. Smoluchowski, Carnegie Institute of Technology, ''Recent Developments in Order-Disorder Phenomena''; E. Orowan, Cambridge, England, ''Brittle Fracture of Triaxial Stresses''; F. Seitz, C. I. T., ''The Multiplication of Electrons in Crystals by High Electrostatic Field''; I. Esterman, C.I.T., ''Resistivity of Germanium Samples at Liquid Helium Temperatures''; J. E. Goldman, Westinghouse Research Laboratories, ''Influence of Atomic Order on Magnetic Properties''; Cyril S. Smith, University of Chicago, ''Grain and Interphase Boundaries in Metals''; A. W. Lawson, University of Chicago, ''New Techniques in High Pressure Research.''

In addition, regular sessions of papers concerning the solid state will be held on Friday and Saturday.

Unesco News

A Unesco Mission arrived in the Philippines early last month to study problems of civic information and education and to help in developing a program of adult and primary education. Floyd Reeves, specialist in educational administration on leave from the University of Chicago, will direct the work of the Mission, assisted by Paul Hanna, of Stanford University, and Dean Cliff A. Lewis, Ontario College of Education, Toronto. The Philippine Government will meet part of the expenses of the mission, which will last about three months. This is the second contract of its kind concluded by Unesco with a member state. The first calls for a similar mission to Afghanistan.

The *Unesco Courier*, a monthly newspaper which is published in Paris and which reports global activities of the Organization, will soon be available to U. S. readers on a subscription basis. Orders may be placed with the Columbia University Press, New York City 27.

Deaths

Ladislaw Farkas, 44, professor of physical chemistry at Hebrew University, Jerusalem, died December 31 in an airplane crash while en route to the U. S. He was well known among physical chemists for his research in reaction kinetics and photochemistry, and especially for his fundamental investigations of the orthohydrogen-parahydrogen conversion.

Townes Randolph Leigh, 68, dean emeritus of the College of Arts and Sciences and head of the Chemistry Department of the University of Florida, died in Gainesville on February 15. Appointed acting vice president of the Unversity in 1934, Dr. Leigh became vice president in 1946 and, in 1948, was given the title of honorary vice president.

Bailey Willis, 91, professor emeritus of geology at Stanford University, and former president of the Seismological Society of America, died in Palo Alto, California February 19. From 1884 to 1916, Dr. Willis had served with the U. S. Geological Survey. The second volume of his autobiography is in process of publication.

W. A. Anderson, 49, curator of the Phanerogamic Herbarium and associate professor of botany at the State University of Iowa, died February 20.

Russell W. Porter, 77, artist-astronomer who made the detailed sketches of the 200-inch Palomar telescope, died in Pasadena, California February 22. Dr. Porter accompanied Admiral Peary to the Arctic, and joined several other expeditions to Greenland, Baffin Land and Franz Josef Land.

Keith L. Maurer, 53, electrical engineer with the Bell Telephone Laboratories, died February 25 at his home in Rockville Centre, New York.

W. J. Conway, professor of chemistry at Fordham University, died February 28 in Teaneck, New Jersey.

The Lepidopterists' Society is now sponsoring or preparing to initiate cooperative projects on phenology and butterfly migration and on a systematic-biological monograph of Nearctic butterflies. The society was formed in 1947 for the purpose of maintaining close contacts between all persons, in all nations, interested in any aspects of the study of Lepidoptera. It now publishes a monthly periodical, *The Lepidopterists' News*, which contains reviews of biological and taxonomic subjects, abstracts of recent papers on Lepidoptera from the world literature, and short communications from members. Research papers are excluded. The only condition for membership is payment of dues, which are $2.00 for 1949. Each member receives a subscription to *The Lepidopterists' News*. Remittances may be sent to the editor, C. L. Remington, Osborn Zoological Laboratory, Yale Station, New Haven, Connecticut.

A method for the quantitative determination of phenol and cresol in complex biochemical samples by counter-current distribution has been developed by Army investigators at Camp Frederick, Maryland. The counter-current distribution method, the basis of which is the partition of a soluble substance between two mutually immiscible phases, has been used in antibiotic and antimalarial investigations, but has had only limited use in the field of analytical chemistry. The new application of the method is described in a report, ''The Determination of Phenol and Cresol in Complex Biochemical Mixtures'' (PB 95891), which can be obtained from the Photoduplication Service, Library of Congress, Washington 25, D. C. The price is $3.75 for photostat and $2.00 for microfilm. Orders should be accompanied by check or money order payable to the Librarian of Congress.

Publication of "Pharmacological Reviews," a supplement to be included with the last issue of each of the three annual volumes of the *Journal of Pharmacology and Experimental Therapeutics*, will begin with the *Journal's* April issue. About 160 pages will be devoted to each issue of the supplement, which will be edited by Louis Goodman, with the assistance of J. H. Comroe, C. A. Dragsted, H. A. Eagle, A. McG. Harvey, O. Krayer, C. C. Pfeiffer, and M. L. Tainter. The first issue will contain articles on the anticholinesterases, drug-protein interactions, ganglionic blocking agents, adrenergic blocking agents, and salicylates. The supplements may be ordered from the *Journal* separately at the rate of $2.00 each, in advance, or by increasing the payment for the *Journal* subscription from $15.00 to $18.00 per year.

The National Research Council of Canada is extending its wartime research on snow problems related to the operation of tracked vehicles to cover the general problem of snow mechanics. The Dominion spends at least $20,000,000 every year in snow removal. Transport over snow also presents special difficulties and provision must be made for the pressure exerted by ice against dams. Problems like these are under study by the Research Council's Associate Committee on Soil and Snow Mechanics, which sponsored a recent survey of snow centers in the western U. S. and Canada by Marcel de Quervain, Swiss snow scientist on loan to Canada, and D. C. Pearce.

Motion pictures made with X-rays are being produced at the University of Washington Medical School with apparatus designed by Robert F. Rushmer, assistant professor of physiology. The subject is placed against a fluoroscope screen, which glows when struck by X-rays, and thus produces an image. Because X-rays would fog the camera film, the lens of the movie camera is faced away from the screen and the image is projected to the lens by a series of mirrors. The camera is protected by a lead shield. A speedy technique for processing the film makes it possible to show the movies the same day they are taken. Dr. Rushmer is working on a way to synchronize the X-ray current with the camera shutter so as to minimize the subject's exposure. The Seattle Orthopedic Hospital is using the X-ray movies to study the heart in action.

A study of Peruvian culture, part of Cornell University's broad program of cultural anthropology, was started last month under the direction of Allan Holmberg in Callejon de Huaylas, a mountain valley along the north coast of Peru. This region is undergoing a transition to modern industrialization and Dr. Holmberg will analyze the human and social problems involved. The Institute of Ethnology of the University of San Marcos is collaborating with him in the work. The Peruvian study is conducted in coordination with the other projects of the Cornell program, which is supported by the Carnegie Corporation. Alexander Leighton has been working with American Indians in the Southwest and Lauriston Sharp has been in Siam since last summer. M. E. Opler plans a research trip to India this fall.

The University of Illinois' College of Dentistry plans to offer a course of six round table discussions on **"Current Advances in Dentistry"** this fall, to be transmitted by telephone from coast to coast. Telephone connections from Chicago are made by ordinary toll call to the various cities and loud speakers amplify the speeches in local meeting rooms. Lantern slides, brochures, and other material are furnished to the participating groups. The University's telephone extension courses were begun two years ago by Saul Levy, chairman of the program.

Recently Received—

The Cavendish Laboratory, by Sir Lawrence Bragg. (19th Autumn lecture to The Institute of Metals, delivered 16 September 1948.) Published by the Institute, 4 Grosvenor Gardens, London, S.W.1, England.

The First World Health Assembly, by James A. Doull and Morton Kramer. (Reprint No. 2894 from the Public Health Reports.) Washington 25, D. C.: Supt. of Documents, U. S. Government Printing Office. $.10.

Intellectual abilities in the adolescent period: their growth and development, by David Segel. (Federal Security Agency Bull. 1948.) Washington 25, D. C.: Supt. of Documents, U. S. Government Printing Office. $.15.

Bulletin Scientifique de l'Association des Ingénieurs Electriciens Sortis de l'Institut Electrotechnique Montefiore, January 1949, No. 1. Siege Social, Rue Saint-Gilles, 31, Liège, Belgium. 50 fr.

Education in Panama (Bull. 1948, No. 12) and Education in Venezuela (Bull. 1948, No. 14) by Delia Goetz. Office of Education, Federal Security Agency bulletins. Washington 25, D. C.: Supt. of Documents, U. S. Government Printing Office. $.25 and $.30, respectively.

Report of Activities, April 1945–March 1948, and Summaries of Research prepared by the Board for Scientific and Industrial Research, Government of Palestine. Copies obtainable from the B.S.I.R., P.O. Box 607, Jerusalem at 3/.

Annual Reports for 1945–47 (Nos. 58–60) of the Marine Biological Station at Port Erin, Isle of Man, prepared by J. H. Orton. Liverpool, England: University Press. 5/.

British Marine Gas Turbines (the 13th Parsons Memorial Lecture) by T. W. F. Brown. North-East Coast Institution of Engineers and Shipbuilders, Bolbec Hall, Newcastle upon Tyne, England.

Make Plans for—

14th North American Wild Life Conference, March 7–9, Statler Hotel, Washington, D. C.

American Chemical Society, 115th national meeting, March 28–April 1, San Francisco, California.

American College of Physicians, 30th annual session, March 28–April 1, New York City.

American Orthopsychiatric Association, annual meeting, April 4–7, Stevens Hotel, Chicago.

Erratum: **The International and Fourth American Congress on Obstetrics and Gynecology** is scheduled to take place May 14–19, 1950 in New York City rather than in 1949 as originally reported in *Science*, (February 25, pg. 217).

Oak Ridge National Laboratory

Alvin M. Weinberg

Oak Ridge National Laboratory

DURING THE TWO YEARS that the development of nuclear energy in this country has been the responsibility of the U. S. Atomic Energy Commission, the large national laboratory has emerged as a new entity, a new experiment in the conduct of organized research. Each of the laboratories—Argonne, Oak Ridge, Brookhaven—bears an individual stamp imprinted by its history and its geography. This individuality manifests itself in differences in atmosphere, in program, and in aims. Thus, in order to understand the Oak Ridge National Laboratory it is necessary first to trace its history.

The laboratory was organized under the name Clinton Laboratories (after the town of Clinton, Tennessee, about eight miles from Oak Ridge), in the fall of 1943. At that time it was a branch of the Metallurgical Project—the University of Chicago Metallurgical Laboratory and the Clinton Laboratories comprised the major units of the Project, under the overall direction of Arthur H. Compton. The laboratory itself was directed by M. D. Whitaker, now president of Lehigh University.

The main job of the laboratory was to produce and extract plutonium on a gram scale in order to test the feasibility of the whole Hanford project. For this purpose an air-cooled graphite reactor was constructed. This reactor, the first with provision for large scale heat removal, began operation on November 4, 1943, and has operated satisfactorily as a research instrument and an isotope producer ever since. In addition, a chemical pilot plant for plutonium extraction was built; this is a relatively small version of the huge concrete structures at Hanford, where plutonium is extracted on a large scale by methods first proved at Clinton Laboratories.

Since the laboratories were in effect a pilot plant—at least on the chemical side—for the DuPont-operated Hanford Engineer Works, it was natural that the DuPont Company played an important role in the early history of Clinton Laboratories. The University of Chicago operated the institution; however, the scientists and engineers at the DuPont Company and at the University of Chicago collaborated in designing the reactor and the chemical facilities, and DuPont was the construction contractor for the whole installation. In addition, the laboratories were used as a training ground for the workers at DuPont who were ultimately destined to operate the Hanford establishment. Many of the laboratory's operating staff were actually DuPont employees on loan to the University of Chicago. Thus industrial and academic influences have both been strongly felt at the laboratory from its earliest days. An atmosphere which is a blend of these two has naturally developed there.

The original purpose of Clinton Laboratories dictated the composition of its staff. Chemistry and chemical engineering (the chemical engineering carried out in the "technical" division, so called because the name is in common use by the DuPont Company) made up more than ninety percent of the scientific effort. This emphasis on chemistry and chemical engineering at Oak Ridge has in some measure persisted ever since. In addition, there was a small physics staff that directed the construction of the reactor and performed experiments with it, a small biology and medical staff, and an operation staff of technicians who later took charge of the routine production of radioisotopes. The technical direction of the laboratory at this time (1943–46) was the responsibility of R. L. Doan, research director.

Oak Ridge functioned as an adjunct of the Chicago Metallurgical Laboratory all through the war. Relations with Chicago were extremely close—monthly information meetings were held there at which research results from the two groups were exchanged and discussed. There were many problems—usually chemical—which were attacked jointly.

The very close relation between Clinton and Chicago remained until the end of the war. In June 1945, when the laboratory population had grown to 1,088, 250 of them technical staff members, it was arranged by the Manhattan Engineer District to transfer the laboratory operating contract to the Monsanto Chemical Company of St. Louis. The laboratory therefore withdrew from the University of Chicago Project and embarked on an independent course, with an overall program much broader than the originally conceived program of chemistry and chemical engineering. A number of scientists from Chicago who had been interested in the long range possibilities of atomic energy joined the laboratory, and its program veered toward the development of new reactor types. Physics and mechanical engineering were strengthened, since these disciplines are important for reactor development. In addition, there was a general broadening of the laboratory's work in pure science.

The large scale production of radioisotopes for scientific and therapeutic purposes was established as an important function of the Clinton Laboratories in 1945. It has continued ever since to be one of the most significant activities of the laboratory—and in fact, one of the most significant activities of the whole Atomic Energy Commission.

In May, 1946, Dr. Whitaker left the laboratory to become president of Lehigh University, and Dr. Doan returned to the Phillips Petroleum Company, from which he had been on leave. E. P. Wigner, on leave from Princeton University for a year, was named director of research and development, and J. H. Lum of the Monsanto Company became executive director.

The year during which Professor Wigner directed the laboratory was one of intense activity and expansion. A metallurgy division was established, and the biology division increased greatly in size. Under the direction of A. Hollaender, its approach to the problem of the biological effects of radiation became microbiological and biochemical rather than mammalian. The physics, chemistry, technical, and health physics divisions also increased in size and scope.

The laboratory program centered even more closely than before around the science and technology of nuclear reactors, although this preoccupation with reactor development was not so much the result of Commission directive as it was the outgrowth of the natural interests of the staff, particularly Dr. Wigner.

One of the most interesting activities at the laboratory during this period was the Clinton Laboratories Training School, directed by F. Seitz. Professor Wigner and his group at the Chicago Metallurgical Laboratory had done a great deal of long range thinking on the possibilities of nuclear energy, and on the codification of nuclear technology into a discipline which had its own tradition and could be conveyed to newcomers in the field. Because of security restrictions it seemed impractical to carry out the necessary training in nuclear technology within the usual educational agencies. Professor Wigner therefore conceived the notion of establishing a nuclear technology training school within Clinton Laboratories. To this school were invited about 40 scientists and engineers, both industrial and academic, interested in entering the new field. The "students" took part in the regular laboratory activities besides attending classes given by staff members, and after the year's stay they were expected to carry their training back to their home institutions.

Although the training school operated for only a year its alumni include several of the best known figures in the American atomic energy effort. There were administrative difficulties of the sort that beset most enterprises at the outset, but the training school was a success as measured by the influence its students have had on the national nuclear energy development.

Professor Wigner's leave from Princeton ended in August, 1947. About the same time, the Monsanto Chemical Company decided, in agreement with the Atomic Energy Commission, not to renew its contract for operation of the laboratory. There followed a period of administrative uncertainty, during part of which the University of Chicago was the presumptive contractor. This period ended March 1, 1948, when the Carbide and Carbon Chemicals Corporation took over operation of the laboratory, now called Oak Ridge National Laboratory, on a four-year contract. The Carbide Corporation had already been operating the other two Oak Ridge installations—the K-25 gaseous diffusion plant and the Y-12 electromagnetic plant—and the extraordinarily well-equipped process and development laboratories connected with them.

Two events of extreme importance to the laboratory occurred during 1946–47. First, the Oak Ridge Institute of Nuclear Studies was organized. This agency, representing 19 southern universities,[1] seeks to establish cooperative arrangements between the Oak Ridge National Laboratory (as well as the other plant laboratories) and the member institutions in all scientific areas where such cooperation can be fruitful for the laboratory and for the member institutions. Thus, arrangements are made, via the ORINS, for students from outside universities to do Ph.D. thesis work at Oak Ridge. Again, faculty members of the ORINS universities are given the opportunity to work in Oak Ridge National Laboratory or in the plant development laboratories, to learn new techniques and to meet distinguished men in the field who often visit the laboratories, and to use this knowledge in their own research and teaching activities. In this respect the Oak Ridge Institute of Nuclear Studies operates in much the same way as do the Associated Universities at Brookhaven, or the Board of Governors at Argonne. It is to be hoped that the Oak Ridge National Laboratory will play a profoundly important part in the scientific and cultural development of the Southland. The degree to which this promise is fulfilled will depend, of course, on the imagination brought to bear on developing fruitful means of contact between the laboratory and the southern region.

[1] Alabama Polytechnic Institute, University of Arkansas, University of Alabama, Duke University, Emory University, University of Florida, Georgia School of Technology, University of Georgia, University of Kentucky, Louisiana State University, University of Louisville, University of North Carolina, University of Mississippi, University of Tennessee, Tulane University, University of Texas, University of Virginia, Vanderbilt University, Catholic University of America.

The second event of great importance was the decision, on December 27, 1947, to concentrate reactor technology at the Argonne National Laboratory and to concentrate at Oak Ridge chemical technology, isotope production, and basic research in chemistry, physics, biology, and metallurgy, the basic research to be carried out in such a way as to stimulate cooperation with the southern institutions and the ORINS. In a certain sense this decision represented a partial return to the original concept of the old Clinton Laboratories, the chemical engineering installation of the Plutonium Project. However, more and more of the laboratory's effort had been directed toward reactor technology and basic research since the early days. The decision to merge the ORNL reactor effort at Argonne naturally caused considerable uncertainty among the scientists at Oak Ridge, the degree of dislocation varying from division to division, depending on how the new directive affected work done there.

It is fair to state that the laboratory has readjusted to its new status remarkably well, and has even acquired greater stability and permanence, because:

(1) The question of contractor has been settled on a long term basis; (2) The relative positions of basic research in the sciences and applied chemical technology have been established—it has become clear that it is perfectly possible for the two to flourish side by side, and in fact, to be fertilized by each other in this juxtaposition; (3) Personnel relations at the Carbide and Carbon Chemicals Corporation are handled well, in a manner consistent with the fact that the scientific staff has an esprit de corps and a loyalty to Oak Ridge; (4) Finally, the role of the Southern universities in the laboratory has been defined, and the hope that Oak Ridge will become the center of basic research in the South materializes with each additional Ph.D. student, with each visiting faculty member, and with each lecture by an Oak Ridge scientist at a Southern institution.

At present the laboratory population is about 2,000, including about 600 technical staff members. The laboratory is divided into six scientific divisions: biology, chemistry, health physics, metallurgy, physics, and technical. In addition, there is an operating department, responsible for radioisotope production and pile operation, and several service departments.

About half of the laboratory's work is classified. The other half includes basic studies in many fields, some of which have already become almost classical. Among these studies are:

Neutron diffraction. This technique, for which the chain reactor is ideally suited, has become an extraordinarily powerful tool for the investigation of the structure of hydrogen-containing crystals. Since chain reactors are so expensive that in all probability only large organizations like national laboratories will ever be able to afford them, the use of neutron diffraction for the systematic study of crystals and molecular structure is apt to remain a most important basic scientific function of the national laboratories.

Ion exchange methods in inorganic chemistry. The systematic separation and purification of chemical compounds by selective adsorption on organic zeolites have been developed at ORNL as a tool in many chemical investigations. For example, the preparation of exceedingly pure (99.9% or better) rare earths was first performed at ORNL, and has since become a fairly routine procedure.

Isolation and chemical properties of elements 61 and 43. Element 61, prometheum, and element 43, technetium, were first isolated in milligram amounts at ORNL from the fission product wastes, and many of their chemical properties have been determined. The work on these elements typifies the sort of large scale "hot" operations which the extensive radiochemical facilities at ORNL make particularly feasible.

The facilities of the Oak Ridge National Laboratory bear evidence of the diversity which is the mark of a war-born activity. The biology division is housed in buildings which were intended for use in the electromagnetic isotope separation process, but which have been converted into one of the best-equipped biological laboratories in the world. The metallurgy laboratory is equipped with one of the largest exclusively experimental extrusion presses in the country; the physics division has at its disposal a helium liquefier and, jointly with the chemistry division, a Van de Graaf machine in addition to the chain reactor; the chemistry division possesses superb, high level, large scale hot laboratories, in addition to such relatively standard apparatus as an electron microscope and an X-ray and optical diffraction laboratory. This is only part of the equipment for which many millions of dollars have been spent at Oak Ridge National Laboratory since its inception.

In addition to the equipment at ORNL proper, there are available in the neighboring plant developmental laboratories excellent facilities for work in optical and mass spectroscopy, as well as huge vertical magnets suitable for cosmic ray investigations. Relations between ORNL and the two plant laboratories have been very close—to the mutual benefit of all three organizations—ever since the laboratory and the plants have been under one contracting agency.

Oak Ridge National Laboratory represents a unique experiment in scientific and governmental administration. It is a national institution operated by a private corporation for the purpose of furthering nuclear chemical technology on the one hand, and basic research, in conjunction with the Southern universities, on the other. It is thus a microcosm in which are projected many elements of our modern American—and Southern—society.

Can such an experiment be made to work? It is important to remember that the national laboratory for nuclear research is a new species—that there are no blueprints for the successful national laboratory—and that there are probably several administrative setups that will prove to be workable. It has been stated that industry is not suited to manage a national laboratory dedicated in good measure to basic research—yet the experience of ORNL during the last year under Carbide management has demonstrated that first-rate basic research can be done in an industrial framework. One important reason is the fact that the subtle relations between staff and contractor have been so handled as to take into account the basic loyalties of the staff, which go primarily to the national laboratory rather than to the contracting agency.

Again it has been suggested that the successful national laboratory should be located close to a large city. Oak Ridge is rather isolated. But life in Oak Ridge and the other atomic cities has many attractive features. There exist cameraderie and opportunities to take active part in community and cultural activities which are quite beyond the prospect of the average city dweller. In large measure these features of life in Oak Ridge compensate for the cultural advantages of the large city—which so often are available but are left unused.

But it may be that the laboratory draws its essential strength from its position as the largest scientific institution in the South. It is commonplace to observe that the Southland is undergoing a modern industrial revolution—that living standards are increasing, and that, as a concomitant, a cultural rebirth is in the making. But the South has a long way to go, especially in the sciences. In making its influence felt throughout the scientific departments of the Southern universities, Oak Ridge National Laboratory, through the agency of the Oak Ridge Institute of Nuclear Studies, has a worthy educational mission to perform. Should it fulfill this mission then this fulfillment—this curious by-product of the atomic bomb—will almost surely rank in importance with any future technical advances which Oak Ridge National Laboratory—or any laboratory—can hope to achieve.

On the Calculation of Planet Temperatures From the Composition of Meteoritic Matter

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IN A RECENT PAPER, BROWN AND PATTERSON (2) STATE "the conclusion appears irrefutable that meteorites at one time were an integral part of a planet" similar in characteristics to the earth. The evidence for this conclusion which they emphasize especially consists of certain thermodynamic computations made on the basis of data which they have compiled. Careful analysis indicates, however, that even if we grant the assumptions involved in making these computations and even if we use the data assembled by Brown and Patterson, we should arrive at conclusions which are at variance with those proposed by these authors.

Brown and Patterson's thermodynamic calculations depend fundamentally on the assumption "that the observed distributions of elements [within meteorites] represent equilibrium distributions . . . [which] must have been established at temperatures of the order of 3,000° C and pressures of the order of 10^5–10^6 atms." The pressures specified depend, in turn, on the value assumed for the equilibrium temperature. It seems pertinent, therefore, to examine carefully the basis of the particular choice of temperature, and the degree of reliability of the value proposed.

The choice of 3,000° C as the equilibrium temperature is based on the correlations of data on equilibrium distributions between silicate and metal phases with the heats of formation of the oxides, in terms of the following *approximate* thermodynamic expression:

$$-RT \ln K \simeq \Delta H. \qquad (1)$$

The reliability of the calculated temperature depends, therefore, on the closeness of ΔH's for the formation of oxides and silicates respectively, and on the possible error involved in the use of equation (1).[1]

Adequate thermodynamic data on silicates are very sparse. There are, however, half a dozen cases yielding sufficient information (*1*) to make a comparison between the ΔH's calculated from data on the heats of formation of silicates and of oxides respectively. The pertinent information is summarized in Table 1.

TABLE 1

COMPARISON OF ΔH'S FOR REACTION (2) CALCULATED FROM HEATS OF FORMATION OF SILICATES AND OF OXIDES RESPECTIVELY

Silicate	$\Delta H_f - \Delta H_{f\,FeSiO_3}$	Oxide	$\Delta H_f - \Delta H_{f\,FeO}$	Deviation
Al_2SiO_5	− 350.2 kcal mole⁻¹	Al_2O_3	− 315.7 kcal mole⁻¹	− 34.5 kcal mole⁻¹
$BaSiO_3$	− 80.5	BaO	− 68.7	− 20.8
$CaSiO_3$	− 104.4	CaO	− 87.4	− 17.0
($FeSiO_3$)	......	(FeO)	......	.....
$MgSiO_3$	74.0	MgO	− 81.8	7.8
$MnSiO_3$	− 27.8	MnO	− 32.2	4.4
Na_2SiO_3	− 97.7	Na_2O	− 35.2	− 62.5

Even if we omit consideration of the case of Al, since there may be some doubt as to just how to correct the silicate data for the difference in valence states, it is apparent that differences from 4 to 60 kcal can be encountered. These deviations would have a profound effect on the calculated temperature, as will be indicated shortly.

The method used by Brown and Patterson (*2*) to obtain 3,000° C as their estimate of the temperature depends on the validity of equation (1). They have recognized, as have all physical chemists, that implicit in the use of this equation is the assumption that entropy changes in the reactions considered are negligible. Practically no reliable data are available to examine this assumption in the present systems.[2] In the absence of information on entropy changes, *equation (1) can be relied upon only for large ΔH's,* especially when the reactions considered occur at elevated temperatures; *yet Brown and Patterson find agreement with a temperature of 3,000° only for data with small values of ΔH,* as is apparent from their figure 3 (*2*). The me[illegible]od of presentation which they have used, however, tends to obscure the magnitude of these deviations. An enlightening insight into the seriousness of these discrepancies can be obtained from the following considerations.

From the data compiled by Brown and Patterson, it is possible to calculate temperatures for each of 16 reactions of the type

$$M + FeSiO_3 = MSiO_3 + Fe \qquad (2)$$

if one uses equation (1) and the oxide ΔH's. It is a significant coincidence that, on the whole, the higher the ΔH the higher the temperature (see Table 2);

TABLE 2

TEMPERATURES CALCULATED FROM HEATS OF REACTION FOR OXIDES

ΔH kcal/ mole O atom	T °K	ΔH kcal/ mole O atom	T °K
4.1	− 1,580	7.8	3,320
19.3	6,450	− 8.2	2,700
23.6	2,650	− 13.2	4,950
23.6	2,620	− 30.7	5,000
25.1	2,960	− 48.7	6,900
35.3	3,400	.....	....
39.3	4,900	.....	....
43.3	5,200	.....	....
67.3	4,200	.....	....
78.3	4,800	.....	....
86.3	7,600	.....	....

in other words, the more nearly one approaches a region where equation (1) is likely to be reliable, the higher the calculated temperature. For the Ca reaction, with the highest ΔH, T becomes 7,606° K. Furthermore, if the silicate enthalpy data are used instead of the oxide data, T becomes 9,200° K in the calcium case. Since entropy data are lacking, the correct answer may be even higher. Even an exceedingly conservative estimate for ΔS of only 1 cal mole⁻¹ deg⁻¹ makes a temperature in the neighborhood of 10,000° K highly plausible. In any event, one is forced to the conclusion that an estimate of 3,000° is based on the least reliable region of the data available,[3] and that the most justified use of equation (1) leads to considerably higher temperatures.[4]

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[1] The propriety of using thermodynamic data obtained at temperatures near 300° K to draw conclusions about processes which occurred at temperatures from 10 to perhaps 30 times greater also requires critical comment. This aspect of their computations is not clearly dealt with by Brown and Patterson; nevertheless, it will not be pursued further in the present communication.

[2] K. K. Kelley (*3*) has reported standard entropy values of 16.2 and 21.8 cal mole⁻¹ deg⁻¹ for $MgSiO_3$ and $MnSiO_3$ respectively, at 298° K. Thus a ΔS of 5 entropy units occurs in at least one known case. Even at 3,000°, the additional uncertainty due to the neglect of ΔS thus becomes at least 15 kcal.

Since there can be little doubt that the assumed temperature of equilibrium of 3,000° is far too low, we can turn attention to the pressure calculation. The basis of the estimate of 10^5 atm is the deviation between zur Strassen's experimental equilibrium constants and those calculated for the meteoritic matter. By assuming that temperature changes make no significant contribution, Brown and Patterson calculate that pressures of 10^5 atm could produce the difference. This calculation is correct in principle if we grant the assumption that there is no significant difference between zur Strassen's laboratory temperature of about 1,800° K and that in the planet of origin of the meteorites. However, it is quite clear from the preceding remarks that the temperature at which equilibrium was attained (if indeed the process is an equilibrium one) is substantially higher than 1,800°. Just how much higher it need be, to satisfy the fortyfold increase in equilibrium constant, cannot really be said. We might use the van't Hoff relation for the temperature dependence of the equilibrium constant, but the necessary integration can be carried out only with the additional assumption that ΔH does not change over a temperature interval of several thousand degrees, an assumption which is most hazardous, particularly if we approach a temperature region where the metals begin to vaporize.

The second argument which Brown and Patterson introduce to justify the acceptance of a pressure factor is again highly questionable. In considering the reaction

$$M + FeS = MS + Fe \qquad (3)$$

they find, in contrast to the silicates, no correlation between the equilibrium constant and ΔH. In proceeding to explain this apparent anomaly, they point out that the heats of formation of metallic sulfides are considerably lower than those of the corresponding oxides. From this observation, they make the unwarranted conclusion that ΔH for reaction (3) " will be generally considerably smaller" than ΔH for a reaction of the type of (2). Such a conclusion is itself unjustified, because ΔH for either (2) or (3) measures a *difference* in heats of formation, so that if both MS and FeS have enthalpies of formation equally less than those of the corresponding oxides, ΔH for reaction (3) would be the same as that for reaction (2). Actually, the two ΔH's run very nearly parallel, as estimated from data in Table 6 of Brown and Patterson. In four out of seven cases the *difference* is less than 5 kcal, in two less than 13 kcal, and only in one as high as 19 kcal. With the possible exception of the single value of 19 kcal, ΔH for reaction (3) is not "generally . . . considerably smaller" than that for (2). The differences are well within the most conservative estimates of the unreliability of oxide data for estimating ΔH's of silicate reactions.

It is true, however, that the absolute values of the ΔH's for the sulfide reactions calculated *for the limited number of systems considered* by Brown and Patterson are small, (between − 12 and + 23 kcal), but so are the ΔH's for the corresponding oxide systems (between − 31 and + 20 kcal). In fact, it should follow, since the best correlation between equilibrium constants and ΔH's in the oxide system was obtained for small ΔH's, that the sulfide systems should also show a definite correlation. Actually, as the authors point out, no significant correlation is evident.

From the remarks which have been made above, in connection with the reliability of equation (1), it is not particularly surprising that the equilibrium constants for reaction (3) are not related to the ΔH's; for this is an excellent example of a case where equation (1) cannot be expected to be valid, since the ΔH's are small. Hence, the introduction of the pressure factor to explain the lack of correlation in the sulfide systems is definitely unwarranted, for the lack of correlation is exactly what one should expect when an equation is applied under conditions which do not fulfill the postulates used in its derivation.

A similar procedure applied to any one of many common series of reactions produced in the laboratory under atmospheric pressure would lead one to the contradictory conclusion that pressures of many atmospheres had been used.[5]

Thus, it is apparent that the arguments proposed for the assumption of pressures near 10^5 atm cannot be maintained. The meager evidence which might be used for a qualitative estimate of the pressure points toward a much lower value. The figure of 1.5×10^5 atm quoted by Brown and Patterson is based on an assumed equilibrium temperature of 2,000° K. From the considerations outlined above, it is apparent that the temperature figure should be very much higher, and hence the pressure values considerably lower, perhaps even near 1 atm. There is certainly no convincing basis for a proposal of 10^5–10^6 atm. On the contrary, the evidence points toward pressures much too low to be "comparable to the internal pressures existing within Mars."

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[3] The unreliability of data in the region of small ΔH's is shown forcefully by the *negative* absolute temperature (see Table 2) obtained for a ΔH of 4.1 kcal.

[4] It should be pointed out, in addition, that temperatures calculated from large equilibrium constants, corresponding to large ΔH's, are more reliable than those calculated from small equilibrium contants, corresponding to small ΔH's, because of the logarithmic nature of the function relating K and T [see equation (1)]. Thus, for a K near 4×10^8 (Brown and Patterson's highest value), a tenfold error (i.e. 1,000%) in the equilibrium constant would produce an error of only 22% in the calculated temperature. On the other hand, an error of as little as 50% in a K near 4 would produce an error of 22% in the calculated temperature. Furthermore, for a constant near 2, a 50% discrepancy in K would introduce an infinitely large error in T.

[5] Some conception of the degree of unreliability of this procedure may be obtained from the following information. The very precise data of Herbert C. Brown and his associates (1947) on certain gas-phase equilibria have been analyzed by a procedure essentially the same as that used by Brown and Patterson, in which entropies of reaction are neglected. Representative values of the temperatures calculated are: − 41,000, − 4,500, 2,500, 3,400, 4,500, and 7,100° K in all cases. The actual temperature at which the experiments were carried out was 373° K in all cases.

Thus, even if we grant (for the purposes of the present discussion) the questionable assumptions on the basis of which the computations have been made, we come to the conclusion that the more reliable of the data presented lead to temperatures far higher than the 3,000° reported by Brown and Patterson. Furthermore, their estimate of a pressure of 10^5–10^6 atm, calculated from an assumed temperature of 2,000° instead of 3,000°, cannot be maintained; for, as has been pointed out, the temperature calculations of greatest significance lead to values about five times higher than the assumed 2,000°; consequently, the pressures must be far below 10^5 atm, and a figure as low as 1 atm is entirely consistent with the available data.

Since the temperature and pressure values reported by Brown and Patterson are at variance with those obtained from a careful, critical analysis of the same basic data, any conclusions of cosmological significance drawn from their figures can hardly be proposed as compelling, let alone "irrefutable." While the hypothesis of a single planet of origin for meteorites may be an attractive one (*5*), as indeed its popularity for almost a century (*4*) testifies, there is as yet ***no thermodynamic basis*** for justifying this assumption.

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The Composition of Meteoritic Matter and the Origin of Meteorites

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Professor Klotz (*6*), in his interesting and vigorous discussion of the chemical interpretation by Patterson and the writer (*2*) of the composition of meteoritic matter, has undertaken an analysis of the possibilities of determining the temperatures within the planet from which meteorites may have had their origin. It is unfortunate that Professor Klotz' discussion evidences misinterpretation of the intent of our survey, of the methods used by us in arriving at our conclusions, of the validity of the data accumulated, and of the relative stress placed by us upon the various points in our argument. Each of these items deserves further comment.

In our investigations an effort was made primarily to see whether or not some sort of chemical order might exist in a field of inquiry where heretofore little order has been found. Our work was stimulated by the hope that, should indications of order become apparent, paths might be opened for fruitful and informative meteoritic research guided by sound chemical principles.

The sources of information utilized in our investigations of meteoritic relationships were varied, including notably:

(1) The variation of the nickel content in the metal phase of stony meteorites with the metal phase content and the relationships between the metal phase of stony meteorites and iron meteorites.

(2) The variation of the distribution coefficient of nickel between metal and silicate phases as a function of metal phase content.

(3) The dependence of the distribution coefficients of various elements between the silicate and metal phases upon the enthalpy change of the general reaction $M + FeSiO_3 \rightleftarrows MSiO_3 + Fe$ or $M + FeO \rightleftarrows MO + Fe$.

(4) The major differences existing between the me-

teoritic distribution coefficients of nickel between silicate, metal, and sulfide phases compared with those measured in the laboratory.

(5) The composition of the silicate phase of stony meteorites with respect to eight constituents as a function of metal phase content, and comparison with the composition of plateau basalt and igneous rock.

(6) The ratio of combined iron to metallic iron as a function of metal phase content.

(7) The atomic ratio of silicon to magnesium as a function of metal phase content.

(8) Frequency distribution relationships for various elements in meteorites as compared with distributions in igneous rocks.

(9) The frequency distribution of the metal phase of stony meteorites.

Given the various relationships mentioned above, the problem is to see whether any theory of meteorite origin is consistent with the data accumulated. We attempted to demonstrate that, from the chemical and geological points of view, the century-old planetary origin theory is quite consistent with the data available, *assuming* internal planetary temperatures of the order of those existing within the earth.

One of the more striking meteoritic regularities we stressed was the strong and surprisingly smooth dependence of the distribution coefficients between metal and silicate phases upon the affinities of the various elements for oxygen. In spite of the crudity of the available data, the necessary use of heats of formation of oxides rather than silicates, and the necessary ignoring of entropy and other corrections, this dependence is most marked, covering a range between platinum and magnesium of over 10^5. The dependence of the distribution coefficient upon ΔH suggests that elements distributed themselves between meteoritic phases under conditions approaching equilibrium, the appreciable scattering about any smooth curve that might be drawn through the points resulting from a combination of possible effects, notably: (a) The crudity of distribution coefficient data; (b) entropy effects; (c) change of ΔH with temperature; (d) pressure effects; (e) the use of oxide rather than silicate data, and (f) the necessary consideration of gross meteoritic matter instead of the stony and iron phases of individual meteorites. (See for example the strong dependence of the distribution coefficient of nickel upon the metal phase content in Fig. 2 in our paper in the *Journal of Geology*.)

Nickel is the only element for which adequate data exists, for comparison of meteoritic distribution coefficients with those observed in the laboratory. Zur Strassen measured the equilibrium $Ni + FeSiO_3 \rightleftharpoons NiSiO_3 + Fe$ at 1,840° K and found a value for the equilibrium constant of 7.25×10^{-3}, which is nearly 40 times smaller than the corresponding value of 0.24 observed in gross meteoritic material. One must ask: At the temperatures which one might expect to find in the interiors of the inner planets, can this major difference be explained in a manner which is consistent with the other sources of evidence outlined above? The line of reasoning used by us was as follows:

It seems probable that the temperature at the *center* of the earth is closer to 2,000° C than to 3,000° C (*4*). On the basis of considerations by ter Haar and others (*5*) on the mechanism of planet formation, it would appear unreasonable to expect temperatures much higher than this to exist in the interiors of any of the inner planets. In view of the relatively low mean temperatures to be expected for the *silicate mantle* of the earth (of the order of 2,000°–3,000° K) and even lower temperatures to be expected for the silicate mantle of the smaller planets, the major discrepancy existing between zur Strassen's measured equilibrium value and the observed meteoritic value appears to be difficult to explain on a temperature increase basis alone.

Prof. Klotz is apparently under the misconception that we estimated the temperature at which equilibrium might have occurred purely on thermodynamic grounds, and then used that calculated temperature in order to estimate the pressure that would be required in order to elevate zur Strassen's observed equilibrium value to that value observed in gross meteoritic matter. Actually, realizing that any estimate of temperature on thermodynamic grounds would be crude at best, we chose a reasonable temperature of an order of magnitude based upon two limits: (a) the lower limit is set by the fact that the material must have been molten, and (b) on the basis of geophysical and astronomical evidence, the estimated internal temperatures within the earth may be used to set an upper limit.

Fortunately zur Strassen measured the nickel-iron silicate equilibrium at two temperatures, thus permitting one to estimate roughly whether or not, by increasing the temperature to a value which is reasonable from the geophysical point of view, an equilibrium constant of the correct order of magnitude could be obtained. Actually, even assuming a substantial value for ΔCp for the system, the temperature required becomes unreasonably high.

We demonstrated that if on the other hand one maintained temperatures not much higher than those utilized by zur Strassen in his experiments (temperatures of reasonable order of magnitude from the geophysical and astronomical points of view), the discrepancy could be explained on the basis of a pressure effect of the order of magnitude of 10^5 atmospheres acting upon the system. This one case would of course not be important in itself. It is significant to note, however, that in the only other case where comparison of meteoritic data with laboratory experiment is possible, namely, the distribution of nickel between the metal and *sulfide* phases, a similar discrepancy exists which is even more difficult to explain on a temperature change basis alone.[1] Indeed, it appears that the two effects together cannot be explained on a temperature change basis alone. Yet, as in the case of the silicate equilibrium, the assumption of a pressure effect of the order of 10^5 atmospheres is sufficient to decrease zur Strassen's measured value to the observed meteoritic value. The nickel distribution between sulfide and metal (on which Prof. Klotz did not comment) is all the more significant because the discrepancy is in a direction opposite to the silicate case, and the molar volume change of the reaction is also of opposite sign. Thus the pressure effect estimated from the sulfide case is nearly identical to that estimated from the silicate case. In the silicate case one might conceivably rationalize the data by making rather drastic assumptions as to temperature and ΔC_p. But to do so in the nickel-sulfide case becomes difficult in the extreme.

It must be emphasized at this point that nickel distributions in meteorites do not constitute the only source of evidence for a pressure effect. There are several regularities, among them, the combined iron to metallic iron ratio, and the silicon to magnesium ratio, both as a function of metal phase content, which can be understood if one assumes a pressure effect, but which are difficult to understand if it is assumed that meteorites were formed in the absence of a gravitational field of substantial order of magnitude.

Concerning Prof. Klotz' objection to our estimate of temperature by means of the demonstrated increase of distribution coefficient with increasing enthalpy change in the reaction $M + FeO \rightleftarrows MO + Fe$, it must be repeated that no effort was made to determine the precise temperature of the presumed parent body. Indeed, how can one determine the precise temperature of a body which may vary in temperature from a few hundred degrees at its surface to perhaps a few thousand degrees in its interior? Rather, it was our intention to see whether the order of magnitude of the temperature indicated by the gross meteoritic distribution data is consistent with the order of magnitude of temperatures generally believed to exist in the interiors of the inner planets, among them the earth, assuming the various contributions to ΔF to be statistically distributed.

In Fig. 3 in our paper in the *Journal of Geology* we plotted the various distribution coefficients against the enthalpy changes. Weighting each point according to our evaluation of the experimental precision of the distribution coefficients, we estimated the most reasonable slope to be one yielding a temperature of about 3,000° C, stressing that "the crudity of such an estimate cannot be over-emphasized." Unfortunately, we did not discuss the method by which we weighted the precisions of the points, believing it to be obvious to anyone reasonably familiar with the difficulties involved in meteorite analysis.

Prof. Klotz has attacked this estimate essentially on the grounds that the greater the enthalpy change, the less important become the other contributions to the free energy change. He suggests that, if one is to estimate temperatures, considerably more weight should be placed upon those cases possessing large enthalpy changes (negative or positive).

This would be correct were it not for an important fact completely ignored by Prof. Klotz: Very large and very small distribution coefficients between meteoritic phases are difficult to determine, the errors being such that large coefficients as determined are usually too low, and the low coefficients are usually too high, by as much as several orders of magnitude. The reasons for this are twofold. First, it is exceedingly difficult to obtain either the metal or the silicate phase in pure form. The metal phase in particular is difficult to obtain completely free of silicate. Second, most meteorite constituents exist in exceedingly small abundance. In such cases, if the distribution coefficient is either very large or very small, the analytical problems become almost insurmountable. As the result of these considerations, *the distribution coefficients for those elements possessing high coefficients must be considered lower limits; the distribution coefficients for those elements possessing low coefficients must be considered upper limits.* Taking into account the objection to drawing a slope through points possessing low ΔH values, the best slope that one can draw in all fairness to the data is one yielding a temperature of the order of 3,000° C. It was our intention to point out only that this is of a reasonable order of magnitude and is consistent with the other points of our argument.

Meteoritic data in their present form are both too crude and too sparse to permit the development of a quantitative proof on chemical grounds alone of the relationships between meteoritic matter and the earth. In particular, one cannot base conclusions (either pro or con) concerning the planetary origin hypothesis on the basis of an isolated consideration, such as Prof. Klotz has attempted. If this were possible, the planetary origin theory would long ago have been completely discounted on the very real and serious astronomical ground that it is difficult to understand how a single body in our solar system could have been shattered into pieces of meteorite dimensions. Rather, the field of meteoritics is like a complicated mosaic in which the various component parts must be pieced together into a reasonable pattern, and then examined for consistency. We found that on the basis of existing data, from the chemical point of view the planetary origin hypothesis is consistent, as distinct from other hypotheses we examined in the same light.

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[1] V. M. Goldschmidt (3) was the first to recognize that the nickel content of troilite is in reality quite low (~0.1%). Previously determined high values were obtained probably due to contamination of the troilite by schreibersite.

Much chemical data must be accumulated before one can say definitely that meteorites did or did not have their origin in a planet. It is difficult to believe that, on the basis of existing data, the hypothesis can be refuted. However, with the development of new methods for studying meteorites (*1*), the time should not be too far distant when precise distribution coefficients are available together with adequate information on distribution coefficients as a function of temperature.

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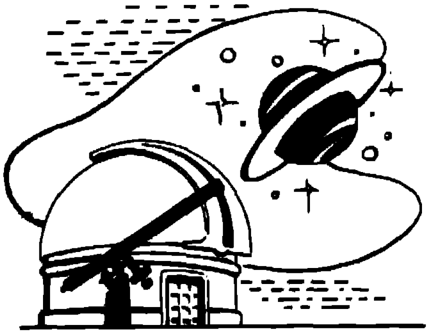

TECHNICAL PAPERS

An Alternative Method for the Culture of *Sciara* Larvae

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In the course of a study of chromosomes with the electron microscope it became advisable to have in the laboratory stock cultures of the so-called fungus gnat, genus *Sciara*. Certain features of the salivary gland of the larva of this insect made its culture desirable for this work. The following method of culture developed in our laboratory seemed to be somewhat more satisfactory than that which had previously been described (*1*). In the earlier method the food supply was largely powdered dry yeast and powdered dry mushrooms, whereas in this method it is a living fungus.

The first step in the procedure is to initiate the growth of the fungus culture. The customary half-pint milk bottles were filled to a depth of about 1½″ with Sabouraud's media. After autoclaving, the media was slanted before cooling to provide more surface for the fungal growth which served as food for the developing larvae. The agar surface was then streaked with the fungus material. Pure cultures[2] of the genera *Haplosporangia*, *Allescheria*, and *Chaetooonidia* were used. All of them provided a satisfactory nutrition for the *Sciara* cultures, but somewhat better success was obtained with the *Chaetoconidia*.

The fungus was allowed to grow several days before the *Sciara* flies were introduced. By the time the larvae appeared, usually about 7 days after the flies were introduced, the fungus had formed a luxuriant mat over the media surface. Apparently most of the feeding is done in the larval stage, for the larvae feed voraciously on the fungus, which then begins to disappear. The growth of the fungus is adequate to provide food throughout the larval stage. The life cycle of the *Sciara* flies occupies about a month, the egg stage taking 5–6 days; larva, 14–15 days; pupa, 3–4 days; adult, 5–8 days. A new fungus culture is necessary for each new generation of flies, and therefore the fungus culture must also be maintained in stock on the Sabouraud media.

The *Sciara* cultures can be kept in the laboratory at ordinary room temperatures provided the temperature does not rise above about 29° C, since it is known that a higher temperature is lethal if maintained for more than a short time (*1*). The larval stage is particularly sensitive to heat, and if it is convenient, the cultures should be kept in an incubator at 22°–24° C.

The advantages which this method seems to offer over the previous one are: (1) a greater biological constancy in the nature of the food supply, (2) elimination of the necessity of repeated periodic feedings during the larval stage and (3) greater ease in maintaining an adequate moisture supply.

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[1] The technical assistance of Mr. Sam H. Stone is gratefully acknowledged.

[2] The initial fungus cultures were kindly provided by Prof. O. A. Plunkett, Division of Botany, University of California, Los Angeles.

Discontinuities in Properties of Water as a Function of Temperature

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It was shown by the author long ago (*1*) that a plot of the densities of many liquids vs. temperature gives a curve that is not smooth, but exhibits inflection points, or kinks, at some intervals. This can be shown to be true for any liquid for which there exist accurate experimental data. But water seemed an exception since the temperature-density curve is perfectly smooth according to figures given in tables used at the present time.

These kinks are often ignored, one reason being that they are not predictable on the basis of current theories. Another is that the previous experimentalists were not aware of them and performed the measurements of densities at regular intervals of temperature. But the kinks, or places of deviation from the smooth path, frequently fall between the observed points, and thus remain unnoticed. Some may attribute these effects to conditions which cause experimental errors of more or less systematic character. This view, in the light of the present data, seems absurd.

It would not be easy to repeat the work of Ramsey and Sydney Young (*3*) for this requires complicated apparatus and takes much time. But there is an easy method of demonstrating these phenomena at moderate temperatures (*2*). The density of propyl alcohol, which had been purified by the procedure of Sidney Young, was determined in a pycnometer at various temperatures between 20° and 80° C. The curve so obtained showed a kink in the same place as it had appeared in the data of Sidney Young. Other liquids also show kinks in this region of temperature, e.g. benzene at 45° C. The temperature was carefully regulated during these experiments, and, by weighing a 25-cc pycnometer, the density can be determined to five decimal places. But this is not needed since the third decimal is sufficient to demonstrate the kinks. If the curve is plotted on graph paper in such a way that a fraction of a millimeter represents the fourth decimal place, the experimental errors are not seen at all. Any deviations from the smooth path must be due to intrinsic causes.

Of all substances known to the author, water seemed an exception in that it alone seemed free of these discontinuities. However, experiments performed recently by the co-author show that this is not true, and that kinks are easily noticed in the density-temperature curve for ordinary distilled water. A 25-cc pycnometer was used in these measurements, and densities determined for the range of temperatures from 47° to 53° C in a thermostat regulated to .002° C. There is a smooth stretch of the curve between 47° and 50° and another between 50° and 53°. These intersect just a little above 50° C, giving a well defined kink (see Fig. 1). Below 47 another smooth stretch of the curve begins, which is not shown on the drawing. Fig. 2 was drawn from the data given in the Smithsonian Tables. As may be seen, the graph is perfectly smooth with only a slight curvature.

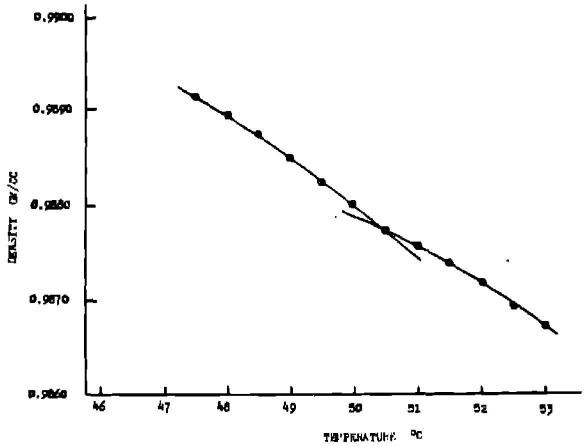

FIG. 1.

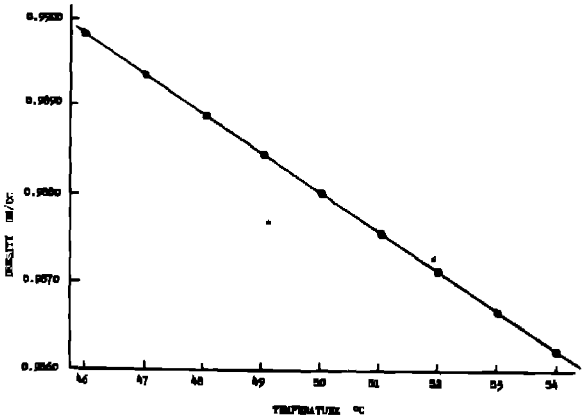

FIG. 2.

There can be no doubt that the experimental results were smoothed by applying the generally accepted rules for drawing a representative curve amidst erratic points due to experimental errors. In this case, however, it is not legitimate to do so because, as explained, the effect is well above the limits of experimental errors, and, on a drawing of the scale shown, the errors do not appear.

This is not the only case in which the figures given in tables are adulterated. There are some instances, especially in the study of liquids, in which the entire experimental work ought to be done afresh.

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A Study of Gastric HCl Formation[1]

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The mechanism whereby parietal cells secrete HCl against a concentration gradient has previously been investigated in preparations of isolated gastric mucosa (*6–10*). In the present study a modification of earlier apparatus has been introduced to permit simple continuous measurement of pH difference across the wall of the isolated stomach of the rat. The experimental procedure entailed the opening of the abdominal wall under barbiturate anesthesia and the injection, into the exposed stomach, of chilled phosphate buffer at pH 7.4. The entire stomach was then removed, opened along the lesser curvature, and rinsed with several changes of the solution with which the apparatus was to be filled. The rugated portion of the stomach was so clamped between the smoothly ground faces of two half-cells (Fig. 1) that it served as a membrane separating the apparatus into two compartments. Ten ml of solution (see below) was then pipetted into each half-cell and a glass electrode immersed on each side. O_2 saturated with water vapor was bubbled through both sides to effect oxygenation as well as mixing. The potential difference generated between the two glass electrodes was read on a Beckman pH meter (Model H). More stable readings were obtained when the cell was placed in a grounded metal box and the housing of the meter was grounded. It was repeatedly observed that the pH difference, as computed from the total potential difference, and as calculated from individual determinations of pH on both sides of the membrane, agreed within 0.2 pH unit. With the development of a pH difference, it was invariably found that the solution in contact with the mucosal surface became acid and simultaneously the solution in the serosal compartment became alkaline.

In every experiment the solutions introduced on both sides of the membrane were initially identical, and when agents were added in the course of an experiment, similar additions were made to both compartments. The standard solution employed was a modified, lightly buffered Kreb's solution (*14*) in which the concentration of phosphate was reduced to approximately physiological levels (942 ml of 0.9% NaCl; 38 ml of 1.15% KCl; 10 ml of 1.18% $MgSO_4$; 13 ml of isotonic phosphate buffer at pH 7.4; 2 gm glucose). Under these conditions, the observed potential difference increased over a period of 3 to 6 hrs from an initial value of approximately zero to a value of about 250 mv, corresponding to a pH difference of about 4 units (Curve A, Fig. 2). Failure of development of a potential difference usually proved to be due to perforations in the membrane.

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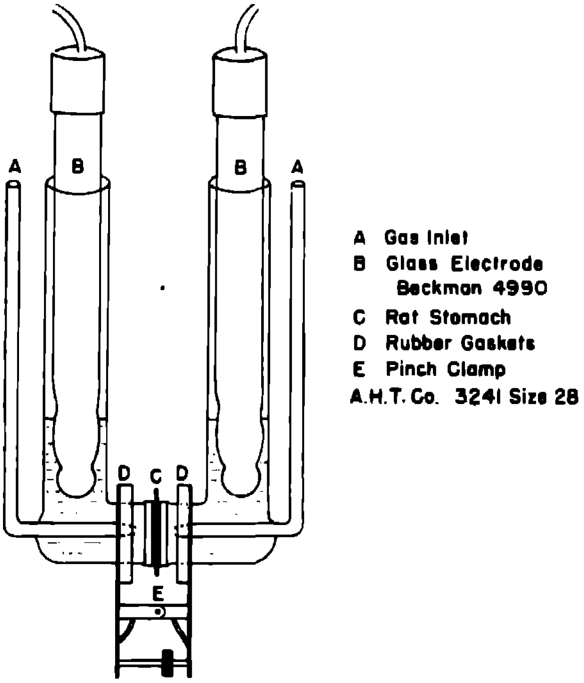

FIG. 1. Cell for the continuous measurement of pH difference across gastric wall.

Successive elimination of the various ionic constituents from the medium revealed that acid production proceeded nearly as well in a medium of 0.9% NaCl solution as in the more complex media. In fact, in a medium containing only 5% glucose and no added salts, acid production proceeded actively for about one hour. It was further found that the presence or absence of glucose in the standard medium had no effect upon the capacity to generate acid, a finding which is attributed to the presence of intracellular nutrient adequate for the duration of the experiment.

In accord with observations of others (*7, 9*), continuous oxygenation of the fluid in the mucosal compartment was found to be essential to prolonged acid production. Interruption of the stream of O_2, or its replacement by N_2 (Curve B, Fig. 2), resulted in a decrease in the rate of acid secretion, although characteristically this decrease was not marked until 15 or 20 min of anoxia had elapsed. Reoxygenation after a period of 40 to 60 min of anoxia resulted in a limited degree of resumption of acid formation. Here again a short time lag was noted.

In agreement with reports in the literature (*15*), a high degree of inhibition of gastric acid formation was obtained with cyanide (0.0003 M) (Curve C, Fig. 2), fluoride (0.01 M), arsenite (0.001 M), and iodoacetate (0.003 M). In addition, tetramethyl *p*-phenylenediamine, reported to inhibit pyridine nucleotide systems (*12*), was found to poison in 0.002 M concentration. Histamine (0.005 M) gave an inconstant stimulation of acid production, while Benadryl (0.004 M), malonate (0.01 M), and phlorhidzin (saturated solution) were without demonstrable effect.

To account for the above experimental results as well as many observations by others, a hypothesis is offered for the mechanism of gastric HCl formation. Consideration has been given to the following additional and pertinent facts: carbonic anhydrase (*2, 3*) and niacin-containing coenzyme (*1*) are abundantly present in the parietal cells; niacin deficiency results in hypochlorhydria (*17*); during periods of HCl secretion the venous drainage of the stomach is enriched with regard to $NaHCO_3$ (*5, 11*); an electrical potential difference between inert electrodes, wherein the mucosa is negative to the serosa in an external circuit, exists across the gastric wall (*16*). Thus chemically and electrically, as well as histologically, the cells under consideration are clearly oriented, and it is suggested that this orientation is a reflection of intracellular stratification of the several enzyme systems, in contrast to a condition in which the enzyme systems are well intermixed. The postulated arrangement of the enzyme systems concerned is roughly diagrammed in Fig. 3.

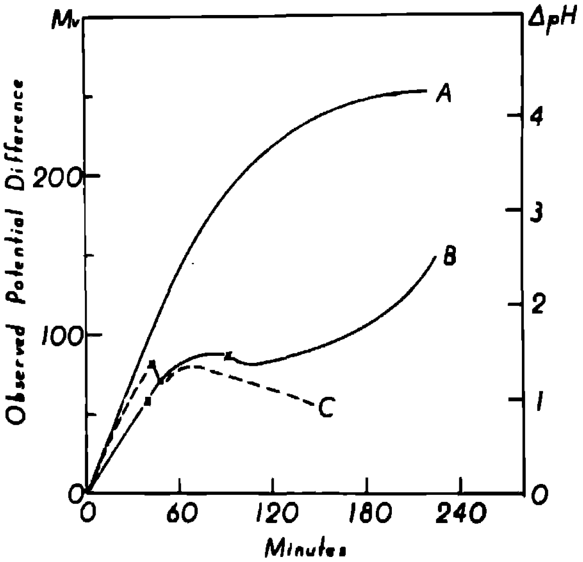

FIG. 2. The development of pH difference across the rat gastric wall. Curve A, standard preparation; Curve B, O_2 replaced by N_2 during interval x – x; Curve C, KCN (0.0003 M) added at x.

The simplest picture that will account for the secretion of HCl against a concentration gradient is that, at the expense of energy derived from the oxidation of some carbohydrate intermediate, RH_2, a local high concentration of hydrogen ions develops at some point close to the gastric lumen. Thence, by diffusion, HCl enters the gastric juice. An obvious and abundant source of hydrogen ions is the oxidation of RH_2 by a pyridine nucleotide coenzyme (cf. Fig. 3). The assignment of the site of reversible hydrogenation of pyridine nucleotide to the *ortho* double bond of pyridine is in fact based upon the appearance of an extra mol of acid during its reduction (*12, 18*), and we offer the postulate that this reaction is the actual source of the hydrogen ions in the present process. Adjacent to the pyridine nucleotide enzyme system, flavoprotein, cytochromes, and cytochrome oxidase may be pictured as lying in successive strata, with carbonic anhydrase intervening between the cytochrome oxidase and the vascular border of the cell. The hydrogen atoms which accumulate on the pyridine nucleotide as it is reduced by RH_2 can then be passed on to the adjacent flavoprotein, which can serve as a reductant of the neighboring cytochromes. Utilizing electrons supplied to it by cytochrome, cytochrome oxidase can now catalyze the formation of hydroxyl ions from gaseous O_2. Whereas in a less oriented system these hydroxyl ions are doubtless neutralized by hydrogen ions arising from the reduction of pyridine nucleotide, in the present hypothesis this neutralization is precluded by the anatomical remoteness of the two processes; instead, the accumulating hydroxyl ions are "detoxified" by reaction with CO_2 in the presence of carbonic anhydrase. The HCO_3^- thus formed diffuses into the blood stream as $NaHCO_3$. Note that in this picture Na^+ and Cl^- do not participate but merely passively accompany the other ions in their diffusions (*4*).

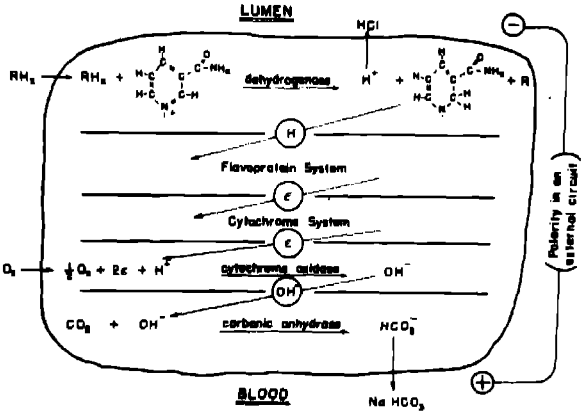

FIG. 3. Postulated stratification of enzymes in parietal cell and mechanism of HCl formation.

The present hypothesis accounts for the obligatory aerobic nature of the process of HCl formation, the dependence of the process upon dietary niacin, and the difference in electrical potential across the secreting gastric wall. It assumes stoichiometrical equivalence of the HCl secreted into the lumen and $NaHCO_3$ discharged into the venous blood, an equivalence recently demonstrated experimentally by Davies (*5*), and it permits the Q_{HCl} to exceed the Q_{O_2} by a factor of as much as 100%, which is also in accord with observations of this author. These relationships become apparent if one considers the over-all balanced expression for the sum of the several reactions postulated in Fig. 3:

$$2\ RH_2 + O_2 \ + 2CO_2 \ \longrightarrow 2R + \underset{\longleftarrow}{2H^+} \ + \underset{\longrightarrow}{2HCO_3^-}$$

The hypothesis finds further support in the observed high concentrations of pyridine nucleotide and carbonic anhydrase in the parietal cells. No novel reactions have been postulated, but rather some degree of lamination of well known enzymes, resulting in a separation of hydrogen ions known to arise from the reduction of pyridine nucleotide and hydroxyl ions which arise from the reaction of reduced cytochrome oxidase with oxygen.

Histochemical attempts to demonstrate the postulated stratification of enzymes have thus far not succeeded, nor have attempts to assemble synthetic acid-secreting membranes along the lines of the foregoing hypothesis. The identity of the hydrogen donor, RH_2, is at present undetermined, but it may be pointed out that any or all substrates susceptible of oxidation by pyridine nucleotide could satisfy the requirements of the present hypothesis.

Thus, a hypothesis for gastric HCl formation is offered, predicated upon two basic assumptions: that the H ions of the gastric juice arise from the reduction of pyridine nucleotide; and that the enzymes of the oxidation-reduction systems in the parietal cell are arranged in successive strata. The hypothesis which follows from these assumptions appears to be in accord with all pertinent facts relating to gastric HCl formation.

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Deposition and Simultaneous Concentration of Dilute Solutions in Paper Partition Chromatography

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In adapting partition chromatography to the identification of histamine in extracts of biological materials, it became evident that the deposition of the customary 0.01 to 0.1 ml volume of fluid to the paper strips would not provide adequate amounts of histamine. The concentrations of histamine encountered were too low relative to the sensitivity of the color reaction employed as indicator on the developed chromatogram. Therefore, it became necessary to deposit the entire final extracts, consisting of 3–5 ml of butanol, without allowing excessive spreading of the solvent on the strips.

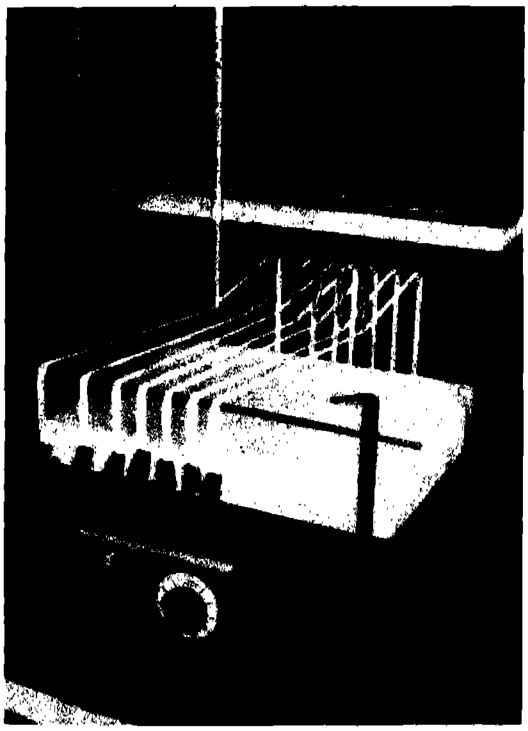

Fig. 1.

Various procedures were tried, such as application of the solutions from very fine capillaries, pipettes plugged with cotton, and pipettes with sintered glass tips with and without simultaneous drying of the solvent with heat and by air blast. Since uniform delivery could not be obtained by any of these methods, the following procedure was finally chosen as most satisfactory.

The paper strips, cut to the proper length and marked at the point of application, are stretched horizontally above a hot plate. Both ends of the strips are weighted by means of window display hooks. Capillary pipettes are brought into contact with the application points marked on the strips. The pipettes are inserted through holes in a rack and held by means of rubber sleeves cut from pressure tubing (Fig. 1). The solutions to be applied to the paper strips are transferred to the pipettes when the temperature at the level of the strips has reached the desired point. For our particular purpose, the pipettes are constructed of 9-mm Pyrex tubing, approximately 20 cm long. To one end an 8-mm length of capillary tubing is fused. The bore of the capillary is of such caliber that it will just admit a 10–12-mm length of 24-gage stainless steel or platinum wire (Fig. 2).[1] With this arrangement, approximately 1 ml/hr of butanol is delivered to and evaporated from the strips at a temperature of 60–70°. The assembly shown in Fig. 1 allows the simultaneous application of solutions to 14 strips with a minimum of attention. The wet spots on the strips spread no more than 2–3 cm at any time. The rate of delivery can be decreased by making the capillary longer or by using less liquid in the wide part of the pipette. After use, the wires are removed from the capillaries by pushing them out with a glass rod inserted through the 9-mm tubing, and the pipettes cleaned by letting them stand in alkaline cleaning solution.

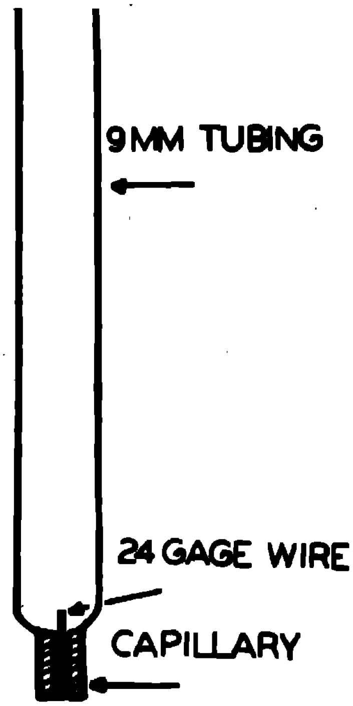

Fig. 2.

Other organic solvents, such as ether, acetone, alcohol, dioxane, etc., can be applied in a similar manner. Aqueous solutions tend to spread excessively on the paper. Solutions containing even weak hydrochloric or sulfuric acid char a variety of the papers tried, even at moderately elevated temperatures. The method may prove useful in other applications of partition chromatography where the concentration of the substance to be identified is low in relation to the sensitivity of the color or other indicator reactions.

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[1] The pipettes were kindly suggested and made by J. J. Svars, Department of Chemistry, Northwestern University Dental School.

A Simple Device For Exposure of Groups of Mice to Uniform X-Ray Doses[1]

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In the course of experiments involving exposure of groups of mice to doses of X-rays[2] it was necessary to utilize a holder which assured uniformity of exposure. Based on a metal "pie plate" device of Snyder (*1, 2*), this device was constructed to minimize the possible errors in dosage due to reflection of X-rays and interference in passage through the metal screen cover.

Circles of ¼"-thick plywood, 5½" and 7½" in diameter, were cut and enclosed in a 2"-wide strip of ½"-mesh wire hardware cloth, so that the wooden plaque was mounted in the middle of the wire cloth band. A cover of plastic screen mesh, ordinarily used in window screening, was made by stretching a piece of the plastic mesh across an embroidery hoop of the proper diameter. (See Fig. 1.)

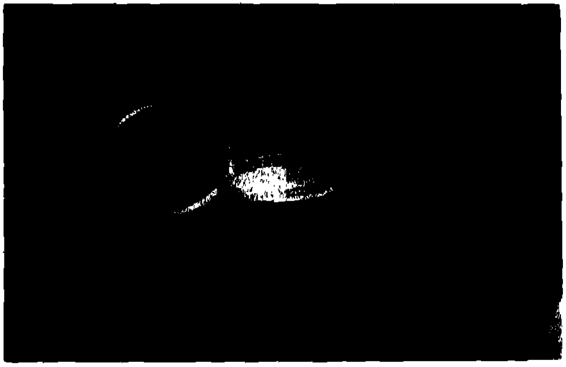

FIG. 1.

In such a device the X-rays do not pass through any metal before reaching the animals, thereby avoiding adulteration of the beam with secondary radiations. The plywood "floor" of the device is elevated 1" above the table; thus there is a minimum of back scatter. Twenty-four mice can be simultaneously irradiated in the 7½" tray and ten to fourteen mice in the 5½" tray.

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[1] Designed in connection with radiation study under Atomic Energy Commission and Office of Naval Research contract.

[2] By Milton Friedman, radiologist, New York University.

Infrared Spectrometry in Metabolic Studies With Deuterium-labeled Steroids[1]

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Infrared spectrometry, which has been of the greatest utility for the detection, identification, and isolation of steroid metabolities excreted in urine (*2, 3, 6*), has been extended to the identification of steroids with deuterium in the molecule. Changes in the infrared absorption spectra as a result of the replacement of hydrogen by deuterium were noted first by Hardy, Barker, and Dennison (*4*) in 1932. The analysis of deuterium-containing organic compounds of biological interest by means of infrared spectrometry has since been described by Herget and Hardy (*5*). Our investigations have been concerned with the detection of a deuterium steroid in an extract containing a number of closely related compounds. One marked advantage of the spectroscopic technique, especially in physiological studies, is that the material to be examined can be recovered without loss or alteration. It is thus possible to employ deuterium as a tracer where a pure compound can be obtained only in limited amount.

In Fig. 1 the spectrum of pregnanol-3(α)-one-20 is compared with the spectrum of the same compound where a hydrogen atom at C-11 and at C-12 has been replaced by deuterium. Two absorption bands attributed to the C-D stretching vibrations appear at 2,165 and 2,145 cm^{-1} in the deuterium-containing compound. In the neighborhood of 1,200 cm^{-1} pronounced differences are apparent in the two spectra. These latter differences can be ascribed to the perturbing effect of the increased mass of the deuterium atoms on the molecular vibrations. In general, with an increase of the number of deuterium atoms in a steroid there is a progressively greater change in the spectrum between 700 and 1,300 cm^{-1}, as well as an increase in intensity of the bands at 2,165 and 2,145 cm^{-1}. These observations are expected since it has been shown that the spectrum in the region 700–1,300 cm^{-1} is extremely sensitive to any change in structure (*3*).

The C-D absorption bands in the neighborhood of 2,150 cm^{-1} are particularly useful for the identification of a deuterium-containing molecule because, in the concentrations used, this region is transparent in the absence of

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[1] Aided by grants from the American Cancer Society (on recommendation of the Committee on Growth of the National Research Council), Ayerst, McKenna and Harrison, Ltd., the Jane Coffin Childs Memorial Fund for Medical Research, the Commonwealth Fund, the Anna Fuller Fund, the Lillia Babbitt Hyde Foundation, the Albert and Mary Lasker Foundation, the National Cancer Institute of the National Institute of Health, U. S. Public Health Service (grants C822 and C440) and the New York Foundation.

deuterium. For this reason increased amounts of the nonisotopic steroid in the sample do not interfere with the detection of deuterated molecules. Absorption in this region not only affords a positive indication of the presence of deuterium in the molecule but forms the basis for quantitative determination of the percentage excess of isotope in the sample. The only effect of dilution with a nonisotopic compound is to increase the total weight of the steroid which must be examined. As an illustration of the sensitivity of infrared analysis, the presence of deuterium could be established in as little as 25 μg of pregnan-11,12-d$_2$-ol-3(α)-one-20 containing five atoms percent excess of the istotope. This was accomplished with a microcell (*1*) of thickness of 3 mm and a volume of 0.04 ml of carbon tetrachloride as solvent. Changes in the spectrum were measured in both the 2,150 cm^{-1} and 700–1,300 cm^{-1} regions. The presence of a C-D bond in a series of different steroids has been established and using thicker microcells, even smaller quantities of substance suffice for estimation.

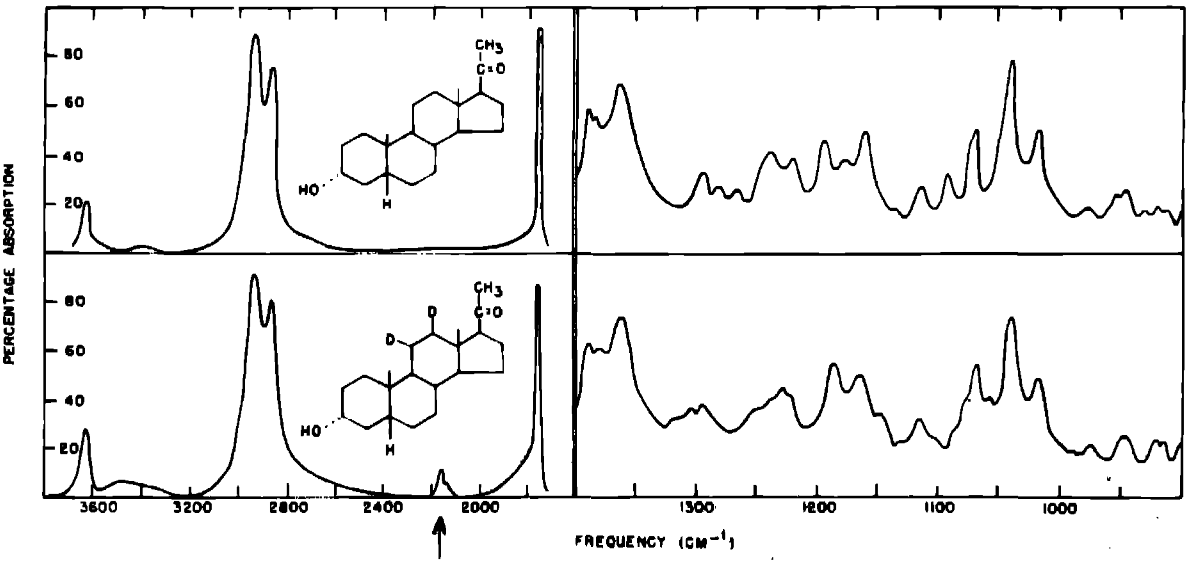

FIG. 1. Infrared absorption spectra of normal and deuterium steroids in CS$_2$ solution; upper curve—pregnanolone, m.p. 150–151°/C; $[\alpha]^{[illegible]}_{D}$ = + 100.0° in CHCl$_3$: lower curve—pregnan-11,12-d$_2$-ol-3(α)-one-20, m.p. 150–151°/C; $[\alpha]^{[illegible]}_{D}$ = + 108.6° in CHCl$_3$. (1 mm cell: concentration 10 mg/ml.) Arrow indicates C D stretching band.

The usefulness of this analytical method has been demonstrated in the following metabolic experiment. Allopregnan-5,6-d$_2$-ol-3(β)-one-20-acetate was injected into a normal woman. After collecting the urine for 20 days, fractionation was effected by the procedures which have been described (*2*, *3*, *6*). Feces collected during the experimental period were studied in analogous fashion. An examination of the region of the spectrum in which the C-D stretching bands occur demonstrated that the isotope was present in both the crude α- and β-hydroxy ketonic fractions as well as in the α- and β-hydroxy non-ketonic fractions from both urine and feces. No such bands were detected in the neutral nonketonic-nonalcoholic fraction. Chromatographic separation of these crude fractions resulted in the separation of several crystalline compounds together with several amorphous fractions or mixtures. These are being investigated further, and the results will be reported in detail at another time. Nevertheless, since certain fractions exhibited strong C-D bands near 2,150 cm^{-1} while others either lacked these bands or had bands of a very low order of intensity, it was possible to locate rapidly the metabolites containing deuterium among the many substances excreted by a normal individual. It was further possible to establish the approximate deuterium content of these metabolites.

It is anticipated that metabolites of the steroid hormones will frequently be obtained in amounts so small that, without some prior knowledge of the approximate isotopic content, analysis by means of the mass spectrometer would be either difficult or impossible. It appears from these results that infrared spectrometry especially in physiological investigations will be a valuable supplement in the detection, analysis, and identification of deuterium compounds.

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The Use of Change in Capacity to Record Cardiac Volume in Human Subjects[1]

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A completely satisfactory method of determining cardiac output in man has not yet been devised. The direct Fick procedure and the various concentration methods, while theoretically sound, require considerable technical ability and facilities and are not applicable in the average laboratory or clinic. The ballistocardiograph, having the advantage of technical simplicity, is open to criticism on theoretical grounds and cannot be applied in situations where tachycardia or abnormal types of cardiac ejection are present. In a search for a method, both simple and widely applicable, we have begun investigations utilizing the change in capacitance of a condenser as a means of recording the volume changes of the intact heart; a method first used by Atzler and Lehmann in 1932 (*1*).

The condenser consists of two aluminum plates 15 cm in diameter placed before and behind the thorax so as to include the cardiac region in their field. The capacity of such a condenser is given approximately by:

$$C = 0.0885\ \frac{AK}{K\ (D-T)} + T$$

where C = capacity; A = area of plates; K = dielectric constant of the chest; D = distance between plates; and T = thickness of the chest (*2*). The dielectric value of the chest is determined by the tissues and tissue fluids of the thoracic contents and by the air in the lungs. Under the conditions of measurement used, the dielectric constant for blood has been shown experimentally to be about 1.75 as compared with 1.00 for air. Varying amounts of blood in the field during the phases of the cardiac cycle thus change the dielectric value sufficiently to cause measurable changes in capacity. It should be noted that blood in the auricles and great vessels as well as in the ventricles contributes to these changes. In addition, movements of the heart will cause some change in capacity by moving blood closer or farther from the condenser plates, and respiratory movements of the chest wall will, likewise, produce capacity changes.

Atzler and Lehmann (*1*) placed their condenser in a resonant circuit, excited by an oscillator near its resonant frequency and connected to a diode detector. Thus, changes in capacity which would shift the frequency of the resonant circuit from that of the oscillator caused a change in the output of the diode which was amplified and recorded on a string galvanometer. A plot of output versus frequency for such a detector reveals a linear relationship over only a small region of the curve, resulting in difficulties of adjustment. To overcome these, we have used the frequency modulation discriminator to convert the changes in frequency to a measurable form. This has the advantage of simple adjustment and linearity of response, and allows the use of a limiter circuit to prevent amplitude changes from affecting the output.

The condenser is used as a portion of the frequency-determining circuit of an oscillator, the output of which is amplified by a broadband, high frequency amplifier and then by a pentode with low plate and screen voltages so that limitation of output with freedom from amplitude changes is accomplished. The output is fed to the discriminator which converts the changes in frequency to a d-c voltage that linearly represents the capacitative variations. This voltage is then amplified by a push-pull, direct-coupled amplifier and applied to a string galvanometer of the usual e.k.g. type. Fig. 1 presents a block diagram of the apparatus.

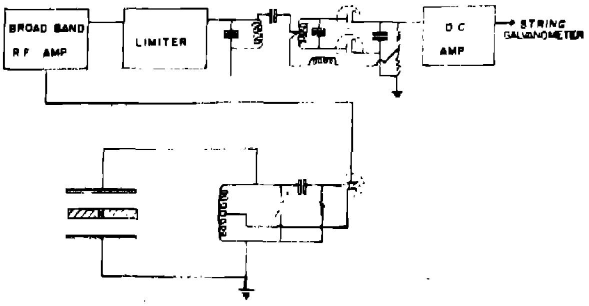

FIG. 1. Block diagram of circuit for recording capacitance changes accompanying the cardiac cycle.

The choice of frequency is determined by several considerations. The chest is a poor dielectric substance and loss current as well as capacitative displacement current will be present.

The derivation from Roberts and Von Hippel (*3*) shows that the power factor $(\tan \delta) = \frac{\sigma}{\omega K}$; where σ is the conductivity of the medium, K is the dielectric constant and ω is the angular frequency. At low frequencies $\tan \delta$ is large and the loss current is maximized. At high frequencies not only are the power factor and loss current minimal, but a greater shift in frequency for a given change in capacity is present, with a resultant larger output. However, at ultrahigh frequencies absorption of the oscillator's energy takes place. As a compromise, for simplicity of circuits, we have chosen a frequency of 10.7 megacycles.

The apparatus is simple in adjustment and operation and gives consistent and reproducible records in both model and human experiments. Representative "cardiodielectrograms" of normal human subjects are pictured

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[1] Preliminary reports covering this work were presented at the Fall Meeting of the American Physiological Society, Minneapolis, Minnesota, September 16 and 17, 1948.

[2] The authors wish to acknowledge the assistance of Dr. Fred A. Hitchcock, Dr. Theodore Wang and Mr. George Jacobi during preliminary phases of this work conducted in the Laboratory of Aviation Physiology and Medicine, The Ohio State University, Columbus. They are also indebted to Mr. Craig Goodwin of the Department of Psychiatry, University of Illinois College of Medicine, Chicago, for helpful advice and the use of equipment in the course of the investigation.

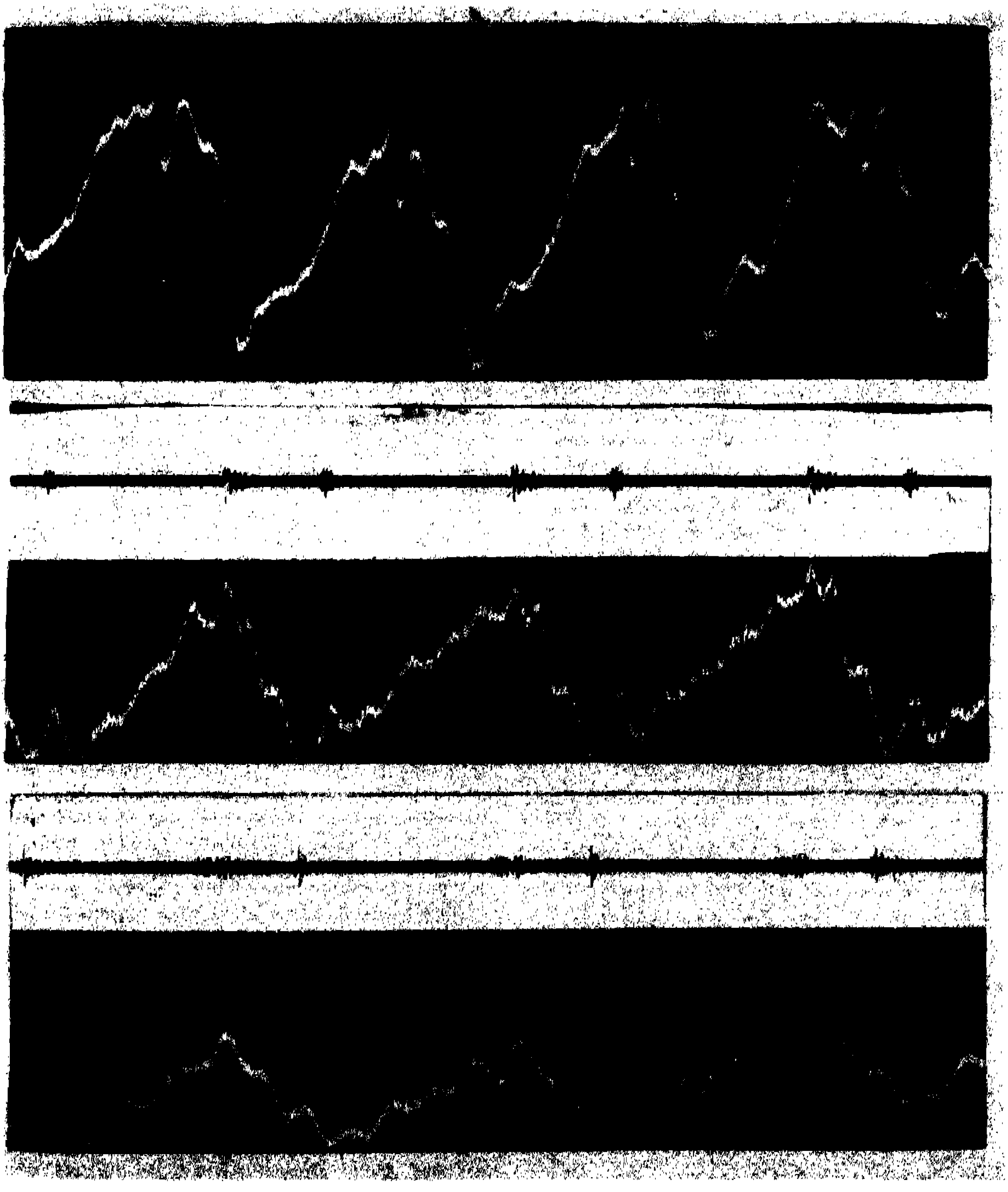

FIG. 2. Simultaneous recordings of phonocardiogram (above) and dielectrocardiogram (below) from normal human subjects. Time intervals are 0.4 sec. Downward deflection indicates a decrease in the volume of blood in the field.

in Fig. 2. Values for stroke volumes, cardiac output, and cardiac indices calculated from such records on the basis of preliminary calibration of the instrument by introduction of known volumes of saline between the plates, fall within the range of accepted normal values, but conclusions as to validity of the method are not yet possible.

Finally, it is obvious that the method is basically applicable to the study of movements and volume changes in other regions of the body.

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Comments and Communications

In Praise of Chisholm's "Social Responsibility"

Dr. George Brock Chisholm's article "Social Responsibility" (*Science*, January 14, p. 27) merits more than the rather limited distribution afforded by *Science*. I am convinced there are many hundreds of intelligent nonscientists who would welcome these fundamental analyses of social phenomena that can lead to war.

Naturally, I am considerably interested in any intelligent means of preventing further destructive wars. I saw the beginnings of World War I in Berlin and London and, as an interned Japanese prisoner in Manila, personally felt the intensely evil effects of World War II.

It seems to me that there must be many other members of the AAAS who will share my belief that we should employ every means possible to prevent a return to another medieval period in the world. Scientists have a stake in this matter, not alone in protecting their own interests but in upholding and buttressing the kind of social pattern suggested by Dr. Chisholm, which is a workable plan and which means their survival.

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Concerning the Nutritive Value of Breads

In a recent publication (November 1948) entitled "Outlook for Bread and Flour Enrichment" (prepared by the Committee on Cereals, Food and Nutrition Board, National Research Council) the following reference is made to certain data reported in one of our publications (Guerrant and Fardig. *J. Nutrition*, 1947, **34**, 523).

"Using various forms of bread to the extent of 30 percent of the diets of young rats, these authors showed the following gains in weight during an 8-week feeding period: whole wheat bread, 82 grams; non-enriched bread, loss; enriched bread, 95 grams; dark bread, 15 grams; milk bread, 20 grams. An important feature of these experiments is that they illustrate the importance of the non-bread components in the dietary in determining the relative nutritional merits of the breads. The presence of 20 percent purified casein in all diets insured the presence of adequate protein for the high demand of young growing rats—much higher than those of slower growing human beings."

Inasmuch as the foregoing statements have led to a misinterpretation of our data, a word of explanation is hereby presented. To this end it seems necessary to point out again that the studies referred to above were concerned particularly with the various flours and breads made therefrom as sources of *thiamine* and *riboflavin*. This we attempted to make clear in the title and elsewhere in our publication. Since this point is not made clear in the report prepared by the Committee on Cereals, and certain pertinent details of our studies are not included, it is my desire at this time to emphasize that we regarded growth rates reported as indications of the relative *thiamine* and *riboflavin* content of the respective breads, and only in these respects are they a measure of the relative nutritive values of the breads.

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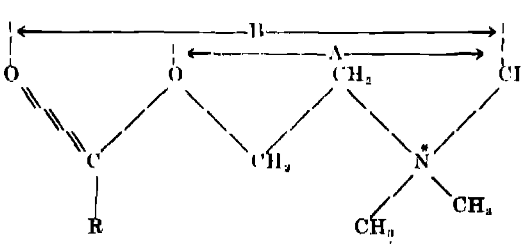
The Structure-Action Relationships of the Choline Group

In an interesting recent article (*Science*, 1948, 107, 94) Pfeiffer has suggested that all the numerous drugs which possess parasympathetic stimulant action "contain a ketone oxygen group adjacent to an ether oxygen linkage with a methyl substituted nitrogen at a distance of two saturated carbon atoms," as in (I):



(I)

He assumes further that these three groups, carbonyl oxygen, ether oxygen, and N-methyl, are prosthetic groups and proceeds to calculate from models the interprosthetic distances A and B. It may be noted in passing that this is an unusual use of the term "prosthetic," which literally means "something added in order to make up a deficiency" and has come to refer in immunology and enzymology to groups which must be added to an inert molecule (usually protein) in order to render it physiologically active (e.g. antigenic or enzymically active); in this sense, the obvious prosthetic group of acetylcholine is the acetyl group which converts the relatively inert substance choline into the highly potent parasympathetic transmitter. It would seem more fitting to refer to the three groups as pharmacologically *active* or *pharmacodynamic* groups. But leaving aside such niceties of terminology, it would indeed be welcome if the complexities of the pharmacology of parasympathetic drugs could be seen to have an underlying basis as simple as Pfeiffer suggests. Unfortunately, his assumptions are beset with difficulties, of which two may be briefly considered: (1) not all molecules containing the three groups disposed spatially as required show parasympathetic stimulant actions and (2) some molecules show such actions but do not contain all three groups.

(1) Not all choline esters of carboxylic acids are parasympathetic stimulants although they contain the three groups at the appropriate mean distances apart. The extraordinary potency of the acetic ester compared with that of its near homologues, such as the formic and propionic esters, is well known, but higher homologues, e.g. the butyric and valeric esters, have scarcely any parasympathomimetic activity (H. C. Chang and J. H.

Gaddum. *J. Physiol.*, 1933, **79**, 255; R. Hunt and R. de M. Taveau. Bull. No. 73, Hygienic Laboratory, U. S. Treasury, 1911) and, when a phenyl nucleus is introduced, as in the benzoic, phenylacetic esters, etc., the compounds appear to have purely nicotine-like properties (R. Hunt and R. de M. Taveau. Bull. No. 73, Hygienic Laboratory, U. S. Treasury, 1911); the benzilic ester is atropine-like (H. R. Ing, G. S. Dawes, and I. Wajda. *J. Pharmacol.*, 1945, **85**, 85). Similarly in the carbamic esters, alkyl substitution in the carbamyl group leads to a sharp decline in parasympathetic stimulant actions which are completely absent in the phenylcarbamic ester (M. B. Bender, M. A. Spirtes, and D. B. Sprinson. *J. Pharmacol.*, 1943, **77**, 107); the dibutyl- and diamylcarbamic esters are atropine-like (K. C. Swan and N. G. White. *Amer. J. Ophthal.*, 1944, **27**, 933).

It may be argued, and probably with justice, that the emergence of atropine-like properties in the benzilic and dibutylcarbamic esters means that these esters have an affinity for parasympathetic endings but block the action of acetylcholine. There would appear to be a gradation of properties which pass through a stage when the esters have little or no affinity for parasympathetic endings and neither stimulate nor paralyze them; thus Swan and White (K. C. Swan and N. G. White. *Amer. J. Ophthal.*, 1944, **27**, 933) found in the dialkylcarbamic esters of choline that the diethyl member was a weak miotic, the di-*n*-propyl member inactive, and the dibutyl member was mydriatic. Similarly, the lower fatty acid esters of choline have stimulant effects at parasympathetic endings; benzoic, phenylacetic esters, etc. have no action, and benzilic and tropic esters paralyze them.

(2) The ethers of choline contain no carbonyl oxygen, but the simple alkyl ethers have well-established parasympathomimetic properties; indeed Dale (*J. Pharmacol.*, 1914–15, **6**, 147) noted that choline ethyl ether resembled muscarine more closely than it did acetylcholine in that its nicotine-like effects were less prominent; the ethyl ether of β-methylcholine is even more like muscarine and is a powerful miotic. Finally, true parasympathomimetic effects, e.g. on the heart and blood pressure, are shown by alkyltrimethylammonium salts which lack both the carbonyl oxygen and the ether linkage (J. H. Burn and H. H. Dale. *J. Pharmacol.*, 1914–15, **6**, 417; R. Hunt. *J. Pharmacol.*, 1926, **28**, 367; R. Hunt and R. R. Renshaw. *J. Pharmacol.*, 1925, **25**, 315; 1926, **28**, 367).

It seems clear therefore that although the carbonyl oxygen, ether oxygen, and N-methyl group occur in many parasympathomimetic drugs, these groups are not all indispensable and their presence in a molecule does not necessarily ensure parasympathetic stimulant action.

One of the most interesting features of Pfeiffer's article is the prominence which is given to the spatial relations of the so-called prosthetic groups. There is indeed suggestive evidence that the actual molecular dimensions of members of the choline group have an important influence on the potency of these drugs. Two dimensional factors appear to be important: (1) the size of the "cationic head" of the molecule and (2) the length of the chain attached to it.

(1) The most active members all contain the $\overset{+}{N}Me_3$-group as cationic head; there appears to be no exception to this rule. Successive replacement of methyl groups by either hydrogen or ethyl leads to a steep decline in parasympathomimetic activities (Table 1). The replacement of one or more methyl groups by hydrogen (R. L. Stehle, K. J. Melville, and F. K. Oldham. *J. Pharmacol.*, 1936, **56**, 473) leads to relatively weak bases. The dissociation constants of these bases are not known, but they would not necessarily decrease in the order of successive replacement of methyl by hydrogen; nor if they did is it likely that they would decrease sufficiently steeply to account for the progressive decline in activity. No doubt both the instability of the cations containing one or more hydrogen atoms and the absence of methyl groups play their part in the observed decline in activity.

TABLE 1

$-\overset{+}{X}$	Mols $AcO \cdot C_2H_4\overset{+}{X}$ = 1 mol acetylcholine		
	Cat's blood pressure	Rabbit intestine	Frog's heart
$-NMe_3$	1	1	1
$-NMe_2H$	50	> 40	> 50
$-NMeH_2$	> 500	> 1,000	> 500
$-NH_3$	> 2,000	20,000	40,000
$-NMe_2Et$	3	2.5*	2
$-NMeEt_2$	400	700*	1,500
$-NEt_3$	> 2,000	1,700*	> 10,000
$-PMe_3$	13	12	12
$-AsMe_3$	66	90	83

* These figures refer to guinea pig ileum.

The successive replacement of methyl by ethyl groups does not produce so dramatic an effect until at least two methyl groups are replaced.[1] The high activity of the mono-ethyl member of the series is particularly interesting. A possible explanation of this observation will be discussed elsewhere. The replacement of three methyl groups by ethyl reduces the muscarine activity of the cation to negligible proportions; this effect of the triethylammonium group (and the similar effect of higher trialkylammonium groups) has also been observed in the analogous ethers (R. Hunt and R. R. Renshaw. *J. Pharmacol.*, 1929, **37**, 309; 1933, **48**, 105), in betaine esters (R. Hunt and R. R. Renshaw. *J. Pharmacol.*, 1933, **48**, 105), in tetra-alkylammonium salts (J. H. Burn and H. H. Dale. *J. Pharmacol.*, 1914–15, **6**, 417; R. Hunt. *J. Pharmacol.*, 1926, **28**, 367; R. Hunt and R. R. Renshaw. *J. Pharmacol.*, 1925, **25**, 315), and in Bovet's acetal compounds (formula II; E. Fourneau, D. and F. Bovet, and G. Montezin. *Bull. Soc. Chim. biol.*, 1944, **26**, 134, 516).

The replacement of the N-atom in acetylcholine by P or As (A. D. Welch and M. H. Roepke. *J. Pharmacol.*, 1935, **55**, 118) also increases the size of the cationic head of the molecule and leads to a decline in activity (Table 1); this result is interesting because the three methyl groups and the high basicity are retained. The change will, of course, increase the "interprosthetic" distances A and B in formula I, but only slightly.

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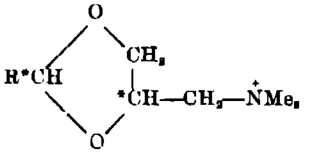
[1] Unpublished work by Mrs. P. Holton in this Laboratory.

(2) If parasympathetic drugs of the general type $R\text{–}\overset{+}{N}Me_3$ are considered, it will be found that the most active member of any group of homologues will usually be the one containing a 5-atom chain (excluding hydrogen atoms) in the group R. In the esters, acetylcholine is much more active than either formyl- or propionylcholine[2]; similarly N-alkylcarbamylcholines are less active than carbamylcholine. Both the nitrous and the nitric esters of choline, which Dale (*J. Pharmacol.*, 1914–15, **6**, 147) found to have considerable muscarine activity, contain 5-atom chains, but the higher and lower homologues have not been studied; the former compound was for many years called "synthetic muscarine." Pyruvylcholine (H. C. Chang and J. H. Gaddum. *J. Physiol.*, 1933, **79**, 255), which contains a 6-atom chain, is moderately active, but its lower homologue, glyoxylylcholine, has not been studied. The acetic esters of formocholine ($HO \cdot CH_2 \cdot \overset{+}{N}Me_3$) and γ-homocholine ($HO \cdot CH_2CH_2CH_2\overset{+}{N}Me_3$) are both less active than acetylcholine (R. Hunt and R. de M. Taveau. Bull. No. 73, Hygienic Laboratory, U. S. Treasury, 1911). In choline ethers, the ethyl ether is more active than either the methyl or propyl ethers (H. H. Dale. *J. Pharmacol.*, 1914–15, **6**, 147). Similarly, in formocholine ethers, $RO \cdot CH_2\overset{+}{N}Me_3$, where R is CH_3, C_2H_5, C_3H_7, or C_4H_9, the most active member is the *n*-propyl ether (A. J. Ewins. *Biochem. J.*, 1914, **8**, 366). Bovet's compounds (II) are interesting; they should exist in



(II)

diastereoisomeric pairs, but, since the distance across the ring between the asterisked carbon atoms will be only slightly less (about 8%) than that between the α and γ carbon atoms in a normal chain, we can regard (II) when R is CH_3 as the nearest approach to the 5-atom chain type; in fact, the compound in which R is CH_3 is markedly more active than the compounds in which R is H or C_2H_5 (E. Fourneau, D. Bovet, F. Bovet, and G. Montezin. *Bull. Soc. Chim. biol.*, 1944, **26**, 134, 516).

In the alkyltrimethylammonium series, the *n*-amyl member was found by Raventos (*Quart. J. exp. Physiol.*, 1937, **27**, 99) to be the most active on the frog's auricle; lower members were less active, and higher members inactive or antagonistic.

There appear to be very few exceptions to this 5-atom chain rule.[3] Simonart (*J. Pharmacol.*, 1934, **50**, 1) recorded that the methyl ether of β-ethylcholine was a more powerful vasodilator than the ethyl ether, but the reverse was true of the corresponding ethers of β-methyl- and β-propylcholine. Hunt and Renshaw (*J. Pharmacol.*, 1932, **44**, 151) found that in the series of thioethers, $RSCH_2\overset{+}{N}Me_3$} I, where R was CH_3, C_2H_5, C_3H_7, and C_4H_9, the *n*-propyl and ethyl ethers were about equally active vasodilators. Among betaine esters ($RO \cdot CO \cdot CH_2\overset{+}{N}Me_3$) the methyl and ethyl esters were also about equally active vasodilators (R. Hunt and R. R. Renshaw. *J. Pharmacol.*, 1925, **25**, 350; 1926, **29**, 17). Finally Kulz (*Arch. exp. Path. Pharmak.*, 1928, **98**, 337) found in the alkyltrimethylammonium series that the *n*-butyl member was the most active on the frog's heart.

This brief survey of the available data suggests that the actual dimensions of what we have called the cationic head and the chain in members of the choline group have an important effect upon the intensity of the action at parasympathetic endings; such a result seems to indicate that a fairly precise fit between the drug cation and some macromolecular structure in the living cell is required if a high degree of activity is to be observed.

We have so far been considering only the muscarinic properties of members of the choline group. It is unfortunate that the relations between structure and the nicotine-like actions of the group are much more obscure. There is some evidence that the size of the cationic head has an important effect upon the stimulant-nicotinic properties (e.g. on sympathetic ganglia) because they are diminished by replacing the N-atom of acetylcholine by P or As and abolished by replacing the three N-methyl groups by ethyl or larger radicals. Among onium salts also, only those containing three methyl groups attached to the central atom (N, P, As, or S) produce contracture of the frog's rectus abdominis (H. R. Ing and W. M. Wright. *Proc. roy. Soc.*, 1933, **114B**, 48). There are indications that particular radicals, e.g. *n*-butyl, benzyl, etc., intensify stimulant-nicotinic activity; thus the butyl ether of choline (A. Simonart. *J. Pharmacol.*, 1932, **46**, 173) and the methyl ether of β-butylcholine (A. Simonart. *J. Pharmacol.*, 1934, **50**, 1) both have striking nicotinic effects on blood pressure. It is generally assumed that β-methylcholine derivatives fail to show stimulant-nicotinic effects; this appears to be frequently but not invariably true: thus, whereas the *n*-butyl ether of β-methylcholine, in contrast to that of choline, has only a slight pressor action after atropine administration, Renshaw, *et al.* (*J. Amer. chem. Soc.*, 1938, **60**, 1765) found that acetyl β-methylthiocholine ($CH_3CO \cdot SCHMeCH_2\overset{+}{N}Me_3$) had an intense nicotinic effect on blood pressure not only after, but even before, the administration of atropine.

The paralyzing nicotine-like action on sympathetic ganglia appears to be, like the curariform action in striated muscle, a general property of "onium" cations. There is no evidence, however, that the paralysis of ganglion cells runs parallel with that of voluntary muscle; indeed, what evidence there is suggests a reciprocal relation—that high curariform activity is associated (in onium cations) with low paralyzing activity on ganglion cells and vice versa. Tetraethylammonium is the best-known example of this inverse relation.

H. R. Ing

Department of Pharmacology, Oxford University

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[2] In the esters $C_nH_{2n+1}\,CO \cdot O \cdot CH_2CH_2\overset{+}{N}Me_3$ the chain length is $n+4$; i.e. formylcholine ($n=0$) has a 4-atom chain. If the carbonyl oxygen of formylcholine were regarded as part of a 5-atom chain, this ester would have to be compared with the formic esters of formocholine and γ-homocholine.

[3] We have neglected the small differences in length between 5-atom chains arising from the different atomic radii of C, O, and N because they would be insignificant in comparison with the differences in the lengths of homologous chains.

NEWS and Notes

The National Science Foundation. On February 25 the Senate Committee on Labor and Public Welfare reported out S. 247, "The National Science Foundation Act of 1949". On March 3 it was officially reported to the Senate in Senate Report No. 90, but there is no basis for predicting when it will come up for discussion or for vote.

The National Science Foundation Act of 1949 is in every detail the National Science Foundation Act of 1948 (S. 2385). Like the latter it is a nonpartisan bill sponsored by Senators Thomas, Kilgore, Fulbright, Magnuson, Smith, Cordon, and Saltonstall. With this sponsorship the Senate Committee feels confident that S. 247 will be passed without much debate and without amendment—possibly without a dissenting vote, as S. 2385 was passed in the spring of 1948. There is also definite reason to believe that the bill will receive the President's signature.

All this sounds very encouraging, provided S. 247 is the kind of legislation scientists want. In private, at least three of the sponsors frankly admit that they prefer a more liberal bill. One of them has expressed the hope that it will be amended in this direction in the House and has confessed that S. 247 was reintroduced into the 81st Congress without modification because it was the easiest course for the Committee to follow, and because this bill is virtually assured of passage.

It is also known that the President favors more liberal legislation, but he seems even more concerned that a National Science Foundation be created and hence will not oppose legislation which accomplishes this primary objective.

Although S. 247 has not yet passed the Senate, it looks as if the House will have the responsibility of determining what final form the National Science Foundation will take. Six bills are already before it and will be considered by the Committee on Interstate and Foreign Commerce, after this Committee is fully organized. Five of these bills (H.R. 12, 185, 311, 1845, and 2308) are similar to H.R. 6007 of the 80th Congress, and are thus like S. 247. One (H.R. 359), introduced by Congressman Celler, follows the pattern of S. 1850 of the 79th Congress. Although H.R. 359 is a liberal bill, it has serious shortcomings, and it may be questioned whether the Congress has before it any bill which provides a wholly satisfactory base for final legislation. Indeed, the House Committee is already receiving letters urging changes in the bills before it. The situation calls for serious study by the Nation's scientists.

HOWARD A. MEYERHOFF

About People

Alan R. Moritz has been appointed professor of pathology in the school of medicine of Western Reserve University, and director of pathology, University Hospitals of Cleveland. At present Dr. Moritz is professor of legal medicine at Harvard Medical School and pathologist-in-chief at Peter Bent Brigham Hospital. In his new post he will succeed **Howard T. Karsner,** who has been appointed Medical Adviser to the Surgeon General, U. S. Navy.

Emory N. Kemler has resigned as acting director of research for New York University to become associate director of Southwest Research Institute, Houston, Texas. Dr. Kemler succeeds **John V. Pennington,** on leave of absence from the Institute.

Ludwig Mies van der Rohe, head of the department of architecture at Illinois Institute of Technology, has been elected to honorary corresponding membership in the Royal Institute of British Architects. A native of Aachen, Germany, Dr. van der Rohe came to the United States in 1938.

Julian Huxley, whose term of office as director general of Unesco ended last December, has accepted an invitation of the British Minister of Education to become a member of the United Kingdom Unesco Committee.

Hagop H. Alexanian, chemical engineer, and **Kenneth C. Kennard,** organic chemist, have joined the staff of the Technical Command, Army Chemical Center, Maryland, in the munitions division and the chemical division respectively.

Ernest B. Babcock, professor emeritus of genetics, College of Agriculture, University of California at Berkeley, has been appointed president of the section of experimental taxonomy of the seventh International Botanical Congress, to be held in Stockholm, Sweden the summer of 1950. Three University of Michigan botanists have also been appointed to the Congress: **Chester A. Arnold** as vice president of the section for paleobotany, and **William Randolph Taylor** and **William C. Steere** as vice presidents of the section of taxonomy.

Beno Gutenberg, professor of geophysics and meteorology at the California Institute of Technology, has been made a corresponding member of the Royal Swedish Academy of Science.

C. Fred Gurnham, New Haven consultant engineer, has been appointed chairman of the Department of Chemical Engineering in the Tufts School of Engineering, Medford, Massachusetts, effective this month.

Donald J. Hebert, head of basic hydraulic research with the Bureau of Reclamation, Denver, Colorado, has been appointed associate professor of civil engineering at Columbia University. Professor Hebert will conduct experimental apparatus and research studies in addition to teaching hydraulics.

Cornelius E. Senseman, special assistant to the Chief of the Bureau of Agricultural and Industrial Chemistry, has retired after more than 30 years of Federal service. Mr. Senseman has played an active role in the chemurgic field.

The American Optical Company has appointed **Charles J. Burton,** formerly with the American Cyanamid Company, and **Walter A. Fraser,** of the Perkin-Elmer Corporation, to the staff of its newly established research laboratory in Stamford, Connecticut.

Harry L. Ebert has been appointed chief chemist of Firestone Industrial Products, Fall River, Massachusetts.

Herschel Weil, of Brown University, has joined the staff of General Electric Company, Schenectady, New York, as a mathematician.

Paul R. Needham has been appointed professor of zoology at the

University of California at Berkeley, where he will direct teaching and research in ichthyology and fisheries biology.

Percy L. Julian has joined the faculty of Fisk University as a consultant in research chemistry.

John J. Phair recently joined the staff of the University of Cincinnati's Department of Preventive Medicine and Industrial Health, succeeding the late **Thomas J. LeBlanc**. Dr. Phair had been chairman of the University of Louisville's Department of Preventive Medicine and Public Health since 1946.

Cushman D. Haagensen, coordinator of cancer teaching at Columbia University's College of Physicians and Surgeons, has been named director of the University's Institute of Cancer Research. Dr. Haagensen is also assistant attending surgeon and assistant surgical pathologist at the Presbyterian Hospital of New York City.

Stuart McLain, former associate director of the Technical Division at Oak Ridge National Laboratory, has recently joned the staff of the Argonne National Laboratory as a senior chemical engineer.

Hans Kohler, formerly a member of the Research Laboratories of the Signal Corps, is now with the National Bureau of Standards in the Electronics Division.

M. K. Goldstein, head of programs research, Office of Naval Research, has been granted leave of absence to serve as a senior technical staff member of the Air Navigation Development Board. On March 17 Dr. Goldstein will receive the Washington Academy of Science's 1948 Academy Award in the Engineering Sciences.

Visitors to U. S.

Yngve Öhman, head of the Stockholm Observatory, arrived here last month for a year's stay. At the invitation of Harvard University, he will study at the High Altitude Observatory in Boulder, Colorado.

Karl von Frisch, Austrian zoologist from the University of Graz, will be a guest of Cornell University's Zoology Department the last half of this month. The subjects of his public lectures there on March 16, 18, and 21, will be "The Color Sense of Bees," "The Chemical Senses of Bees," and "The Language of Bees." Dr. von Frisch will visit other U. S. universities and will return to Europe about June 1.

Stig Karlson, associate professor of obstetrics and gynecology at Stockholm, Sweden, was a recent guest of Clair Folsome, medical director of the Ortho Research Foundation, Raritan, New Jersey. Dr. Karlson, an authority on the physiology and pathology of the uterine musculature, visited the Lying-In Hospital of Chicago University and the New York Hospital of Cornell University's Medical School during his two-week stay.

Eugene E. Rabe, formerly of the University of Berlin, has been made assistant professor of astronomy in the University of Cincinnati's Graduate School of Arts and Sciences and College of Liberal Arts. He will continue work on the International Astronomical Union's minor planets program, with which he has been identified for more than 10 years. As a special project, he is studying the orbit of the planet Eros, discovered in 1898. Dr. Rabe spent some time at the U. S. Naval Observatory in Washington before going to Cincinnati.

Six Indian engineers recently arrived in this country for several months' training in the operating, maintenance, and production phases of fertilizer manufacturing plants. They are: **K. L. Ramaswami, J. Simon, H. G. Rao, H. A. Bhatta, S. C. L. Jain,** and **A. N. Krishna Swami.** Upon their return to India they will take over operation of a new $50,000,000 fertilizer plant at Sindri, 175 miles northwest of Calcutta. The plant, sponsored by the Indian Government, is now being operated by Chemical Construction Corporation, a unit of American Cyanamid Company.

Grants and Awards

The Society of Chemical Industry, London, has awarded its gold medal for 1949 to Foster Dee Snell, president of Foster D. Snell, Inc., New York firm of consulting chemists and engineers. Dr. Snell will receive the medal at the Society's meeting at Manchester, England, July 13, when he will deliver an address on a phase of surface activity.

Henry Eyring, professor of chemistry, University of Utah, recently received the Research Corporation of New York's achievement award, consisting of a plaque and $2,500.

The World Health Organization of the United Nations has been awarded a medal by the Egyptian Government for its action in stopping a cholera epidemic in that country in 1947.

The Alvey-Ferguson Company of Cincinnati has given Columbia University $20,000 to establish scholarships for students in the mechanical and electrical engineering departments of the School of Engineering.

Cornell University's Laboratory of Nuclear Studies has received a gift of approximately $1,000,000 from Floyd R. Newman, a director of Ashland Oil and Refining Company, of Cleveland. The laboratory, opened last October (see *Science*, October 8, p. 375), will be named for Mr. Newman.

Carl Eric Holmquist, a chemist at the Swedish Government Institute for Public Health, has received a grant from the Rockefeller Foundation to study technical hygiene for one year at Harvard University.

George B. Creamer of Syracuse, New York, has been awarded the Sylvania Division American Viscose Corporation Fellowship for the study of cellulose chemistry at McGill University, Montreal, Canada.

The Oberly Memorial Award, given every two years to the American citizen who compiles the best bibliography in the field of agriculture or the related sciences, is offered for 1949. The award is limited to publications issued during the calendar years 1947 and 1948. Those interested in competing should send four copies (either processed or printed) to Marvin A. Miller, Chairman, Oberly Memorial Award, University Libraries, University of Arkansas, Fayetteville, before June 15.

Colleges and Universities

The new biology building to be constructed on the campus of **West Virginia University** will house laboratories and classrooms for physiology, anatomy, genetics, embryology, cytology, bacteriology, plant pathology, taxonomy, and other specialized courses, as well as general courses in botany, zoology and biology. The completion date is set for November, 1950.

Members of the Division of Entomology and Parasitology of the **University of California** have organized a group to study the systematics and economics of plant- and animal-infesting mites. It is hoped that others who are interested in the same problems will cooperate in the projected program. Members of the initial group are: E. O. Essig, A. E. Michelbacher, W. W. Middlekauff, E. M. Stafford, F. M. Summers, A. D. Borden, N. W. Frazier, A. Earl Pritchard, G. L. Smith, W. Harry Lange, D. P. Furman, and L. M. Smith, chairman.

The University of Rochester School of Medicine and Dentistry and Strong Memorial Hospital will dedicate the new wing of the hospital's psychiatric clinic March 31. Among those delivering addresses at the dedicatory program will be Paul Weiss, University of Chicago; Homer W. Smith, New York University; Howard Liddell, Cornell University; Lawrence S. Kubie, Yale University, and Clyde Kluckhohn, Harvard University.

The University of Georgia School of Medicine has opened a school of medical illustration and will offer courses, beginning this fall, for medical students, medical art students, and illustrators in other fields of science. Applications for admission may be addressed to the Registrar, University of Georgia School of Medicine, Augusta.

The Stanford University Research Institute recently opened its new precision gage laboratory to serve Western industry. Its equipment, most of it under contract from the Army Ordnance Department, which closed its San Francisco district gage laboratories in 1945, is capable of accurate measurement down to 25 millionths of an inch. Gage blocks (checked every six months with the National Bureau of Standards) and monochromatic light are used to determine the accuracy of machine parts. The laboratory also has a Magnaflux to test metals for cracks and flaws. All equipment is available to the public at nominal fees to be established on a cost-incurred basis.

The Western College Association will celebrate its 25th anniversary in Claremont, California March 26, and will honor its founder, James A. Blaisdell, former president of Pomona College and president emeritus of Claremont College. The Associated Colleges at Claremont — Pomona, Scripps, Claremont Men's College, and Claremont College—will be official hosts of the Association, which comprises 30-odd colleges and universities in California, Nevada, and Arizona.

Meetings and Elections

The New York University of Education is holding its annual **Health-Education Institute on Social Hygiene and Family Relations** this month, with morning sessions Monday to Friday through March 26.

The Annual **Seminar for the Study and Practice of Dental Medicine** will be held October 23–28 at the Desert Inn, Palm Springs, California. Discussion will be conducted by Arthur C. Curtis, University of Michigan, Wilton Marion Krogman, University of Pennsylvania; Seymour M. Farber, University of California Medical School; Balint Orban, University of Illinois; D. Harold Copp, University of California; Francis A. Arnold, Jr., U. S. Public Health Service; and Paul Popenoe, American Institute of Family Relations, Los Angeles. Detailed information may be obtained from Marion G. Lewis, Executive Secretary, 1618 Ninth Avenue, San Francisco 22.

The Second National Conference on Unesco will be held in Cleveland, March 31–April 2. Over 3,000 delegates are expected to attend the session, which is being called by the U. S. National Commission on Unesco, an advisory body to the Department of State. The principal speaker will be Jaime Torres Bodet, newly elected director general of Unesco.

The Michigan Academy of Science, Arts, and Letters, will hold its annual meeting at Wayne University, Detroit, Michigan, March 31–April 2. Eighteen special-interest groups within the Academy will share research findings in their fields. All interested persons are invited to attend.

The Division of Biological Chemistry of the American Chemical Society will conduct a **symposium on viruses** at the meeting of the Society in San Francisco, March 31. Papers on various aspects of recent virus investigations will be presented by Karl F. Meyer, director of the Hooper Foundation; Cyrus P. Barnum, Jr., University of Minnesota; Seymour S. Cohen, University of Pennsylvania; M. A. Lauffer, University of Pittsburgh; D. G. Sharp, Duke University; Robley C. Williams, University of Michigan; and eight Pacific Coast investigators. The symposium was arranged by W. M. Stanley, director of the Virus Laboratory, University of California at Berkeley.

The Medical Library Association will hold its annual meeting in Galveston, Texas, April 10–14. The Library of the University of Texas Medical Branch will be the host.

The annual Theobald Smith Memorial lecture of the **New York Society of Tropical Medicine** will be held on April 22 at 8:30 p.m., in the auditorium of the School of Public Health, Columbia University, 600 West 168th Street, New York City. Fred L. Soper, director of the Pan American Sanitary Bureau, will speak on "The 1949 Yellow Fever Situation in the Americas." All who are interested are invited.

The Eastern Sociological Society will hold its annual meeting at the Hotel Commodore, New York City, April 23–24.

Linus Pauling, president of the American Chemical Society and director of the Department of Chemistry, California Institute of Technology, will deliver the second lecture of the City

College Chemistry Alumni Association's bicentennial lecture series, April 29, at 8:00 p.m. in the Great Hall, City College of New York, Convent Avenue and 139th Street, New York City. Dr. Pauling will talk on "Structural Chemistry in Relation to Biology and Medicine." The public is invited.

The American Society of Medical Technologists will hold its annual convention June 20–23 at Hotel Roanoke, Roanoke, Virginia. Further information may be obtained from Ida L. Reilly, Roanoke Hospital Association, Roanoke, Virginia.

The American Physical Society, at its recent annual meeting, elected as president Francis W. Loomis, head of the physics department, University of Illinois. I. I. Rabi of Columbia University will serve as vice president for one year and will succeed Dr. Loomis as president of the Society in 1950.

The Oregon Academy of Science has elected the following officers for 1949: W. E. Milne, Oregon State College, president; F. L. Griffin, Reed College, vice president; F. A. Gilfillan, Oregon State College, secretary; and Lloyd Staples, University of Oregon, treasurer.

Dwight Willard Taylor, 17 years old, of the Webb School in Claremont, California, was named the **Westinghouse Grant Science Scholarship winner** at the banquet culminating the Eighth Annual Science Talent Search in Washington, D. C., on March 7. Taylor, who will use the $2,800 award to attend the University of Michigan, made a survey of mollusks on Nantucket Island and reported 76 species previously unknown there.

Caroline Stuart Littlejohn, 16 years old, of Classen Senior High School, Oklahoma City, Oklahoma, received the second place $2,000 Westinghouse Science Scholarship for her general science record and her essay on the mathematical theory of relativity.

Of the 40 high school students selected from 16,218 entrants to come to Washington for the Eighth Annual Science Talent Institute held March 3–7, eight were awarded $400 science scholarships: Thomas Calhoun Barr, 17, Hillsboro High School, Nashville, Tennessee; Pierre Euclide Conner, Jr., 16, Cathedral High School, Lafayette, Louisiana; John Ward Kimball, 18, Phillips Academy, Andover, Massachusetts; Henry Jacob Landau, 18, Bronx High School of Science, New York City; Thomas Francis Martin, 17, Cathedral Latin School, Cleveland, Ohio; Nicholas Reinhardt, 17, Terrace Park High School, Terrace Park, Ohio; Howard Alan Shugart, 17, Herbert Hoover High School, Glendale, California; and Ursula Vivian Victor, 16, Forest Hills High School, New York. The 30 other participants in the Washington Institute received $100 science scholarships.

The annual Westinghouse Science Talent Search is conducted by the Science Clubs of America with funds provided by the Westinghouse Educational Foundation and is administered by Science Service. The $11,000 in science scholarships may be used at any college, university or technical school of the winners' choice to continue training in science and engineering. In addition to the 40 national winners, a list of 260 students awarded honorable mention was announced on February 10 and recommended to college and university registrars who are recruiting students talented in science. Eighteen states conduct Science Talent Searches concurrent with the national competition to determine state scholarship awards.

The panel of judges—Harlow Shapley, Director of the Harvard College Observatory, Steuart Henderson Britt and Harold A. Edgerton, psychologists of New York City, and Rex E. Buxton, psychiatrist of Washington, D. C.—made the science scholarship awards on the basis of a science aptitude test completed by 2,482 of the entrants, recommendations and scholarship records submitted by the students' high schools, and original 1,000-word essays entitled "My Scientific Project."

The 31 boys and nine girls selected for the Science Talent Institute in Washington came from 32 localities in 17 states and the District of Columbia. Three states, Louisiana, Texas, and Utah, have winners this year for the first time.

Of the 320 winners named in the first eight Science Talent Search, twelve have come from the Bronx High School of Science and eight from Stuyvesant High School in New York City; seven from the Forest Hills (New York) High School; and 5 from the Herbert Hoover High School in Glendale, California.

Albert Einstein celebrates his 70th birthday on March 14 and to mark this occasion *Unesco World Review* is issuing a special supplement which will be entitled "Tribute to Albert Einstein." A 30-minute program, written by Niels Bohr, Danish physicist, Jacques Hadamard, French mathematician, and Arthur H. Compton, U. S. physicist, will be released to all radio stations receiving the *World Review*, for broadcast Sunday, March 13.

The Army Medical Department announces the development of a new drug, **"Dramamine,"** that acts as both a cure and preventive of seasickness or motion sickness. The original research was done by Leslie N. Gay, of the Protein Clinic of Johns Hopkins University Hospital, Baltimore, and Paul Carliner, also of Johns Hopkins. Recent experiments showed almost total cure or prevention of seasickness among more than 400 passengers aboard an Army transport in heavy seas.

The Smithsonian Institution has been presented with a collection of burrowing snakes of the Southwest—more than 2,000 specimens of the obscure, insect-eating *Sonora* and *Tantilla,* collected by Edith R. Force, of Tulsa, Oklahoma.

A Special Notice to
Any Prospective Exhibitor
in the
Annual Science Exposition
of the
116th Meeting of the AAAS
New York City,
December 26–31, 1949

If you did not receive a letter inviting your participation in this year's annual Exposition, and if you would like to receive the Official Floor Plan and Booth Rental Information on the release date this month, please write at once to: R. L. Taylor, Assistant Administrative Secretary, AAAS, 1515 Massachusetts Avenue, N.W., Washington 5, D. C.

A New Development in Ocean Wave Research[1]

H. R. Seiwell and George P. Wadsworth

Woods Hole Oceanographic Institution and *Massachusetts Institute of Technology*

APPLICATION OF THE PRINCIPLES of generalized harmonic analysis to oceanic wave observations is here briefly reported. This type of analysis is new to oceanography and has rarely been used in other geophysical practices (*2, 3*). In our case it was applied initially to observed oceanic wave data as a means of overcoming ambiguities and uncertainties arising from the fitting of Fourier series and from apparent misleading indications of periods from periodogram analyses of finite amounts of data.

The hypothesis of generalized harmonic analysis provides a realistic approach to the subject of oceanic wave investigations. As will be shown, the outcome of the applications far exceeded initial expectations. The results obtained identify the method as a powerful tool for this type of investigation and, provided the hypothesis is applicable to the problem, it serves two distinct purposes:

(1) To separate the dynamic and random components of oceanic wave patterns, and to evaluate the physical characteristics of each.

(2) To employ the above results in investigations of the corresponding properties of the physical generating mechanisms.

The dynamic components of ocean wave patterns are presumed to be those generated by systematic action of winds on the sea surface. On the other hand, random components result from variables not considered, such as random motions of the water and local intermittent wind action. Separation of dynamic and random effects in this sense is paralleled in electrical communication, wherein the initial signal frequency is distorted to a varying degree, and distortion of a purely random nature is called noise. On arrival, a message contains the original signal frequency plus a random noise, and the problem is to isolate the initial signal from the message. The analogy to be drawn for ocean waves is that the ocean wave record is comparable to the message, the dynamic portion of the record to the signal, and the superimposed randomness to the noise.

The oceanic wave observations subjected to analyses were obtained in the usual manner, by photographic recordings of sea surface wave heights and by automatic recordings of wave pressure variations at the sea bottom (*1*). Such observations comprise geophysical time series from which discrete values of wave heights are scaled at equidistant (1 second) time intervals. Sequences of values so obtained contain certain inherent dynamic properties, together with certain superimposed random components.

Separation of the dynamic and random components and evaluation of their cyclical and oscillatory characteristics are possible by the hypothesis of generalized harmonic analysis. In this manner we eliminate the objectionable a priori assumptions of Fourier series applications to geophysical time series, and obtain results of dynamic significance. Thus, application of the Fourier series to a finite stationary time series permits representation by an infinite number of sums of sine waves of different periods and amplitudes, whereas the correlogram of generalized harmonic analysis is, like the original series, the sum of a series of harmonics with different coefficients, all in phase. The correlogram brings to light a more realistic and more simplified picture of the physical characteristics of the sea surface pattern. The nature of this information is briefly discussed in connection with an analysis of Wave Record 53-X.

A detailed report by the authors on the method of generalized harmonic analysis, together with a rigorous mathematical treatment of the specific applications and representative examples, will be published shortly. Essentially, the method consists of analyzing the correlogram of auto and cross correlations of the data. Thus, as an example, in the series

$$u(t) = A_1 \sin(\lambda_1 t + \alpha_1) + A_2 \sin(\lambda_2 t + \alpha_2) + \dots\dots\dots\dots A_m \sin(\lambda_m t + \alpha_m),$$

the variance is

$$\mathrm{Lim}\ \frac{1}{2h}\int_{-h}^{h} u^2(t)\,dt = \tfrac{1}{2}\,\Sigma\,(A_j{}^2),$$

and the auto correlation function is

$$r(k) = \frac{\Sigma\{A_j{}^2 \cos(\lambda_j k)\}}{\Sigma(H_j{}^2)}\,.$$

Record 53-X (Fig. 1) designates a 20-min underwater (70′ depth) pressure record from a location one and one quarter miles south of Cuttyhunk Island, Massachusetts, beginning at 0650, September 15, 1948.

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[1] Contribution No. 401 from the Woods Hole Oceanographic Institution and the Department of Mathematics, Massachusetts Institute of Technology.

Previous periodogram analysis of this data, by means of the wave frequency analyzer in use at this Institution (*1*), produced the result illustrated in Fig. 2. The periodogram is a complicated picture with numerous periods. This represents the customary type of oceanic wave record analysis, and in the usual interpretation, two distinct frequency bands would be defined as characterizing the data. The first, not too well represented, lies between 6.5 and 8.00 seconds, and the second, well-defined, between 10.5 and 16.0 seconds. Maximum peaking occurs at 12.5 seconds, with two additional, well defined peaks at 11.5 and 15.0 seconds. Hence, the usual conclusions drawn from this analysis would be that the sea surface roughness pattern consists of two defined spectral bands with a dominating period in the vicinity of 12.5 seconds.

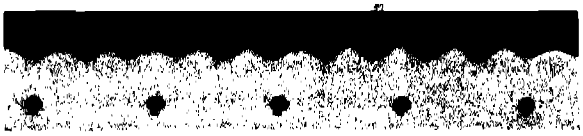

FIG. 1. Portion of Wave Record 53-X. On the original record the upper 30-sec time marks are approximately 1¾" apart.

Although conclusions like these are not readily disproved, the accepted explanations of geophysical phenomena are those that provide the most realistic and simplified hypothesis. In this case, the fallacy in the analysis appears to lie in the fact that the large number of periods shown for consideration is misleading. The mere fact that the data can be mathematically represented in this fashion does not lend significance to any identical period or group of periods. The component periods are not identifiable, and the period bands which may be construed as constituting the oceanic wave pattern do not possess a realistic physical significance. Rather, this type of analysis suggests that the large number of periods in the periodogram may be indicative of some one disturbed period in the series. Thus, it can be demonstrated by a generalized harmonic analysis of the original record (53-X) that the wave pattern is not an interference pattern composed of the numerous periods of Fig. 2, but one that is apparently controlled by a single cyclical component on which is superimposed an oscillatory component of the same frequency. Combination of the two components results in the apparent complex basic wave pattern of the record (Fig. 1). This latter, and more realistic explanation, has been derived for Record 53-X in the following manner.

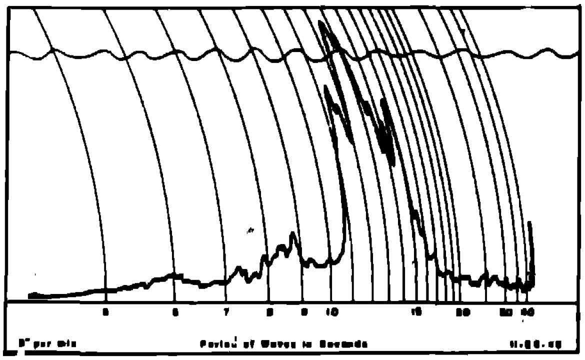

FIG. 2. Results of periodogram analysis of Wave Record 53-X, as given by the wave frequency analyzer.

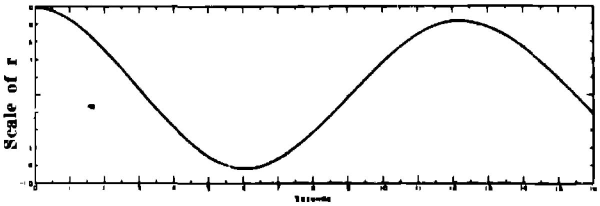

FIG. 3. Correlogram of Wave Record 53-X; 0- to 16-sec lags.

Correlograms of Wave Record 53-X for lag correlations of 0 to 16 seconds, 100 to 111 seconds, and 200 to 211 seconds are illustrated by Figs. 3 and 4. The sinusoidal symmetry of the curves and the time locations of valleys (6.13, 104.13, 202.13 seconds) and crests (12.25, 110.25, 208.25 seconds) indicate a persistent period very near to 12.25 seconds. The variance of the primary data is 0.1824 ft².

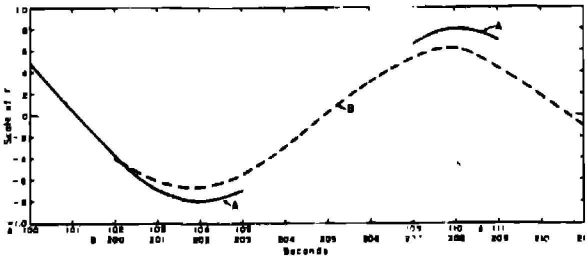

FIG. 4. Sections of correlogram of Wave Record 53-X for the 100- to 111-sec and 200- to 211-sec lags.

The correlogram damps slowly. At the 202nd lag the wave valley has an amplitude of $r_k = 0.66$, and near the 208th lag the crest amplitude is $r_k = 0.62$. The slight asymmetry appears to result from small errors in estimation of the mean value. The mean amplitude for the 16th cycle is taken as $r_k = 0.64$.

In the case where the series consists of a sine term, A sin θt, plus a random residual, we have as a theoretical value of the terminal amplitude of the correlogram

$$r_k = \frac{\text{variance cosine}}{\text{total variance}} = \frac{A^2 \cos \theta k}{2\sigma_y^2}.$$

Thus,

$$A = \sqrt{2}\sqrt{r_k}\,\sigma_y.$$

If the value of $r_k = 0.64$ and that for the variance of the primary data (0.1824 ft^2) is substituted, the theoretical amplitude (A) of the 12.25-second cyclical component in Wave Record 53-X is computed to be: A = 0.49 ft.

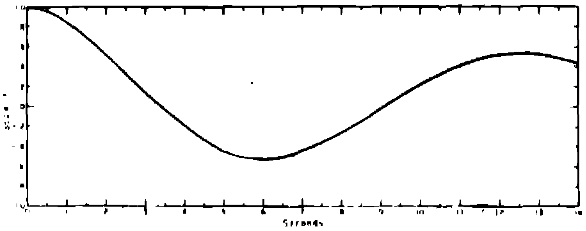

FIG. 5. Correlogram of residuals of Wave Record 53-X; 0- to 14-sec lags.

This value is in close agreement with the amplitude of 0.54 ft computed for the 12.25-second cyclical component by a least-squares fit of Fourier series to the primary data of 53-X. Subtracting this cyclical component from the primary data and computing the autocorrelation functions of the residuals, we obtain the correlogram of Fig. 5. The correlogram damps rapidly to an amplitude of r = 0.54 at the end of the first cycle, and thereafter continues to damp. The variance of the residuals is 0.0636 ft^2.

Substituting above values in the relation

$$\frac{\text{variance of residuals}}{\text{variance of primary data}} = 1 - r_k$$

where r_k is the terminal amplitude of the primary correlogram, we obtain $r_k = 0.656$; a value in good agreement with that of $r_k = 0.64$ for the terminal amplitude of the correlogram of the primary data (Fig. 4).

We may now proceed on the basis that, after extraction of the cyclical component from a finite amount of primary data, the residuals represent the autoregressive part of the primary data. Hence, the total or primary data may be considered to consist of a cyclical component and an oscillatory component, the latter of which is autoregressive. The correlogram of the residuals has a period of 12.25 seconds, identical with that for the primary data. From the Fourier transform of the autocorrelation coefficient, the intensity (S^2) in the periodogram of the residual series is computed. Fig. 6 illustrates the results which show that the energy of this spectrum attains its maximum value ($S^2 = 7.2$) at about 12.25 seconds.

Further numerical computation provides items of verification interest. Thus, multiplying the residual variance by the maximum intensity of the periodogram (Fig. 6) we obtain A = 0.67 ft as the theoretical amplitude of the oscillatory component.

The total amplitude of the sea surface oscillation (C) may now be computed as the square root of the sum of the squares of the cyclical and oscillatory component amplitudes. Thus

$$c = \sqrt{(0.54)^2 + (0.67)^2} = 0.86 \text{ ft.}$$

The mean deviation of the primary data is 0.362 ft; that for the residuals, after subtraction of the cyclical component, is 0.194 ft. Thus, the ratios of mean deviation to standard deviation for each case is: primary data = 0.84 and residuals = 0.77; or the mean deviation is approximately $\sqrt{2/\pi}$ of the standard deviation, a relationship which holds approximately for unimodal curves approaching symmetry.

Application of the hypothesis of generalized harmonic analysis permits the following geophysical interpretation of Wave Record 53-X. The wave pattern represented consists of a well-developed cyclical component (12.25-second period) on which is superimposed an oscillatory component of the same period. The former, which accounts for approximately 64 percent of the sea surface roughness, proceeds through the data as the predictable component, that is, as long as the generating mechanism remains unchanged. The oscillatory component represents the autoregressive part of the data. The cyclical component is presumed to be generated by a prominent oceanic meteorological situation, and the superimposed oscillatory component from local winds and other local disturbances which tend to change the basic wave pattern. The cyclical is the dynamic component, whereas the oscillatory component is random, although it may possess dynamic characteristics.

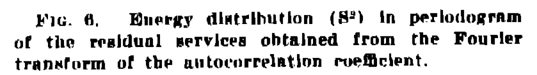

FIG. 6. Energy distribution (S^2) in periodogram of the residual services obtained from the Fourier transform of the autocorrelation coefficient.

Most of the wave records[2] analyzed to date conform to the general pattern of Record 53-X; that is, a well developed cyclical component on which is superimposed an oscillatory component, plus, possibly, other random factors. In a few instances, the cyclical component has been absent, or so weakly developed as to be indistinct. In rare cases, two distinct cyclical components were evaluated from the primary data.

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[2] These records comprise both sea surface and sea bottom observations. For observing methods see reference 1.

The conclusions to be drawn from the foregoing analyses may be summarized briefly as follows:

(1) Periodogram analyses performed on oceanic wave records do not appear to give correct geophysical information. The numerous wave periods, and bands of periods, indicated by this type of analysis do not necessarily possess physical significance.

(2) Application of the hypothesis of generalized harmonic analyses to western North Atlantic wave records indicates that ocean wave patterns are not complex interference patterns resulting from combinations of many wave frequencies, but frequently consist of a single sinusoidal wave on which is superimposed an oscillatory component.

(3) The cyclical component appears to be that generated under the influence of a dominating oceanic meteorological situation, and the oscillatory component by local winds and other local disturbances tending to change the basic ocean wave pattern.

(4) Separation of the cyclical and oscillatory components and determination of their physical properties is possible by generalized harmonic analysis of finite portions of the primary data.

(5) In the case of Record 53-X, the wave pattern is indicated to be composed of a cyclical and an oscillatory component. The former proceeds throughout the data in regular sinusoidal fashion with an amplitude of 0.54 ft and accounts for approximately 64 percent of the variability in the wave pattern. The oscillatory component, with a theoretical amplitude of 0.67 ft is autoregressive, and strongly damped.

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Comparative Electron and Light Microscopic Investigations of Tactoid Structures in V_2O_5-sols

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THE SPINDLE-SHAPED TACTOIDS in Fig. 1, whose biological interest was recognized at an early date (*2*), have been investigated repeatedly with the polarizing microscope (*15*) and by X-rays (*1*). Electron microscopy has not been applied extensively to tactoids, although it has been used by various authors to study aqueous dispersions of tobacco mosaic virus (*10*) and of V_2O_5 (*3*), in both of which tactoids do form under suitable conditions.

In this investigation we studied the development and transformations with time of tactoid structures in a 2% V_2O_5-sol prepared according to the recipe of Zocher and Jacobsohn (*15*). Immediately after preparation a solution of this concentration shows a fine particle dispersion in the electron microscope, without structure or apparent orientation (Fig. 2). These colloidal particles have a mean diameter less than 50 A. In the polarizing microscope a solution of this concentration is optically empty.

In a liquid medium, structures of low rigidity are liable to deform and alter during the drying of speci-

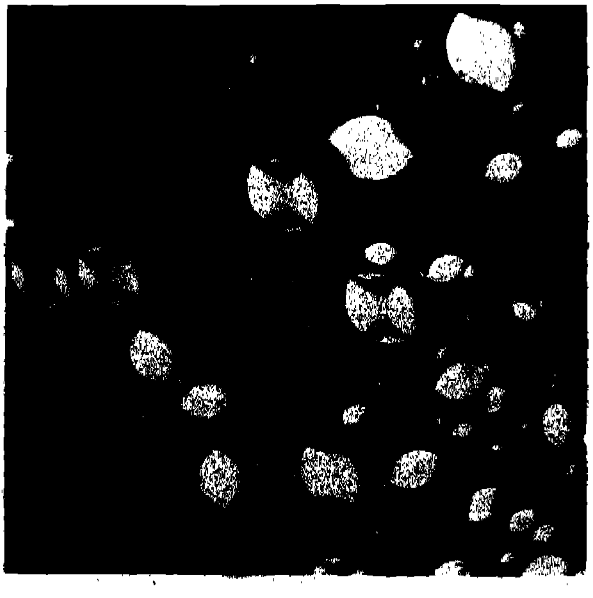

FIG. 1. Photomicrograph between crossed nicols of V_2O_5 tactoids, × 100.

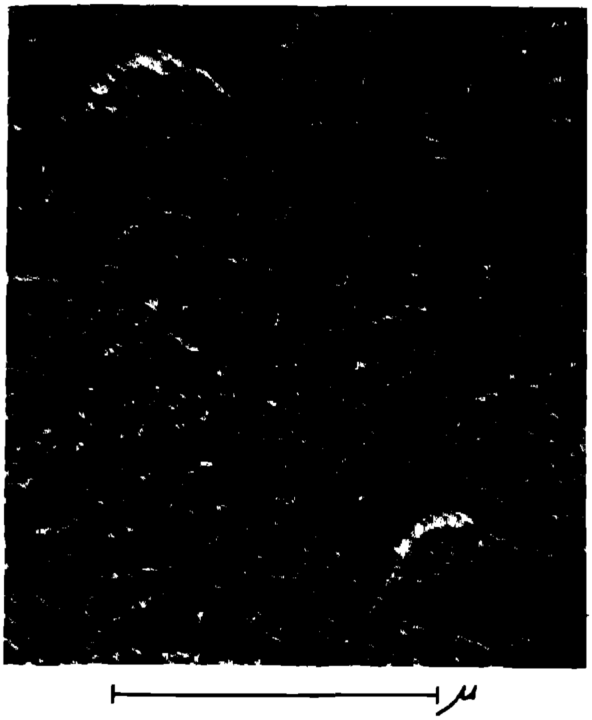

FIG. 2. Electron micrograph of a shadow-cast specimen of a three-hour sample of V_2O_5, showing fine particulate material. ×42,500.

mens preliminary to electron microscopy, so that structural details can be produced which are absent in the original specimen. In the present work with V_2O_5-sols an entire droplet of specimen apparently acquires the consistency of a gel at some period prior to complete drying. This is true only of the older samples, however, and not at all of the freshly prepared ones. As long as one is aware of the possibility of drying artifacts, as well as of other inherent characteristics of electron microscopy techniques, pseudostructures are not a serious drawback but may have real value and give much additional information. In order to get a more complete conception of the properties of a material, the electron microscope should be used in conjunction with other instruments. In the present work, because of the orientation which exists in the materials, the polarizing microscope has been chosen as a second instrument to aid in interpretation. The polarizing light microscope in many cases defines the spatial arrangement of structural elements, although these elements may have dimensions far below the resolving power of the microscope itself.

Electron micrographs of a dried 24-hour specimen show up the presence of tactoids (Figs. 3 and 4). Shadow-casting at very acute angles and stereoscopic electron microscopy reveal that the dried tactoids have exceedingly little thickness and are almost in the same plane as the film and the background gel throughout. In drying, the spindle-shaped bundle of rods collapses upon itself but retains the general outline of the tactoid. At this and at later stages, sheaves of rods also appear. With the polarizing microscope, solutions are observed to develop individual tactoids with time and complex, anisotropic structures after the aged solution has separated extensively into a lower gel-phase (tactophase) and a supernatant sol-phase (actophase) (*15*). The primary and probably significant variable during this aging process is the increase in size of the individual V_2O_5 crystals (flat orthorhombic rods) which form the elements of all anisotropic structures. This steady increase in size follows not only from electron microscopy evidence but also from a continuous increase with time of both

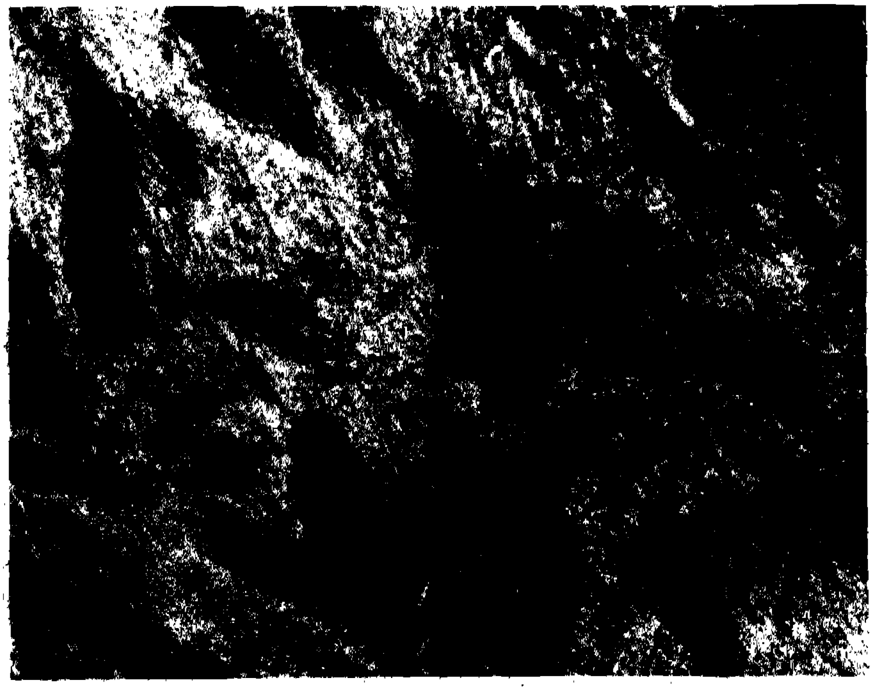

FIG. 3. Electron micrograph of a 24-hour sample of V_2O_5, showing positive tactoids. ×5,000.

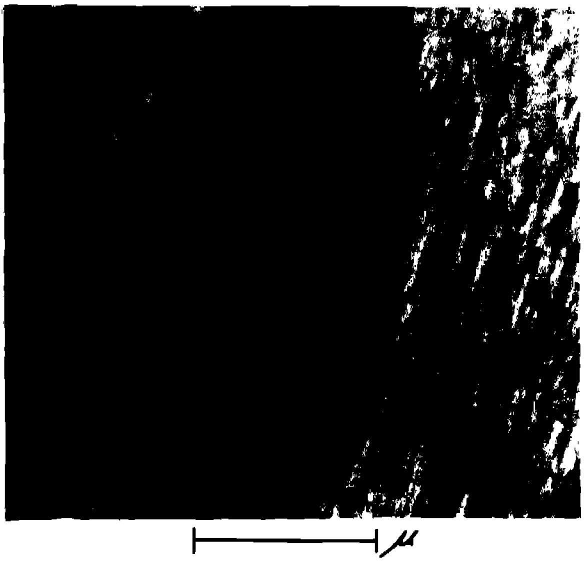

FIG. 4. Electron micrograph of a specimen of a 24-hour sample of V_2O_5 tactoid, taken at higher magnification to show directly the structure of and orientation within a dried, positive tactoid, ×24,000.

magnetic and streaming double refraction in dilute solutions free from structures (*6*), and from thorough X-ray optical investigations (*8*), pertinent results of which are summarized in Table 1.

TABLE 1

DIMENSIONS OF V_2O_5 CRYSTALS IN COLLOIDAL SOLUTION*

Age of V_2O_5-sol	c	b	a
	(In Angstrom units)		
Fresh	50	10	10
2 weeks old	150	20	10
20 years old	1000	100	30

* Results by Ketelaar (*8*).

The electron diffraction patterns in Fig. 5 verify the crystalline growth* for the solutions considered here. The patterns taken over the growth interval are characteristic of V_2O_5 in all cases: bright but broad lines from the early, particulate material (Fig. 5A), an oriented fiber pattern from the 24-hour specimen (Fig. 5B), and sharp, bright lines from a six-day specimen (Fig. 5C). The decrease in line broadening is very pronounced over this short interval.

The quantitative change in chromatic polarization from the center towards the periphery of the original tactoids, observed with the aid of auxiliary double refraction, proves that they are prolate spheroids prior to being dried out. What the electron microscope shows, therefore, is tactoids which have collapsed onto the supporting film, under maintenance of the nematic symmetry of orientation of the tactoid elements (Fig. 4). This drastic reduction in the thickness of tactoids during drying is proof, in addition to ultramicroscopic (*15*) and interference optical (*4*) evidence available, that the *mutually oriented elements of tactoids maintain remarkably large, long-range equilibrium distances in the aqueous medium.* A preservation of the mutual orientation in dried specimens is also indicated by the fact that electron diffraction yields distinct fiber diagrams. Fig. 4 shows the orientation of rods with their long axis parallel to the long axis of the spindle and the *preservation of this orientation.*

Fig. 3 and particularly Fig. 4 show variations in density across the images of dried tactoids which may be due to local coagulation of the rods into larger bundles while the tactoid is drying. On the other hand, ultramicroscopy and particularly X-ray analysis have indicated that the internal density of the original spindle-shaped tactoids is fairly uniform.

Occasionally sheaves of rods are found in electron micrographs of the dried specimens along with or instead of the tactoids. Apparently connected with this is the frequently stratified aspect of the back-

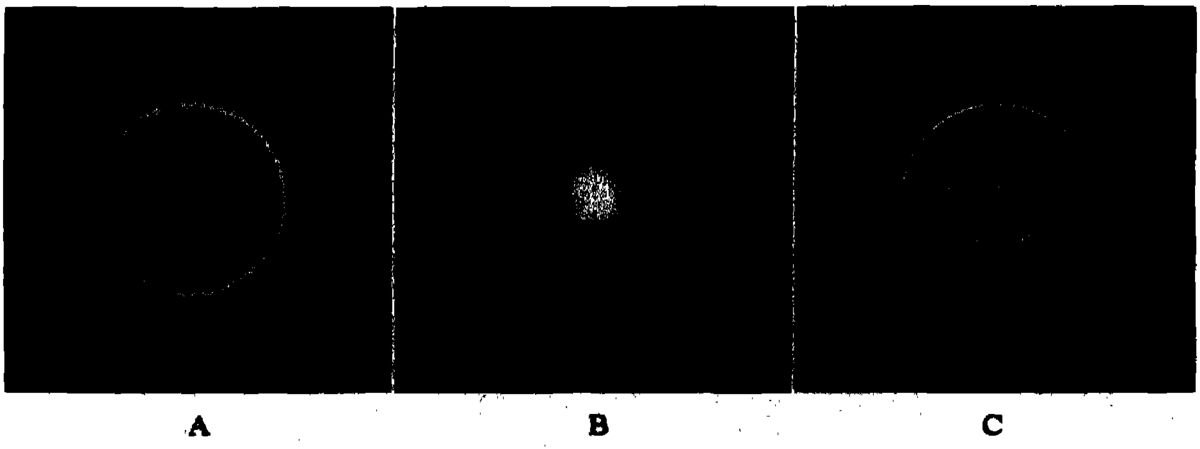

FIG 5. Electron diffraction patterns of V_2O_5: A—three-hour specimen, diffuse, broad lines; B—24-hour specimen, preferred orientation; and C—six-day sample, sharp crystal reflections.

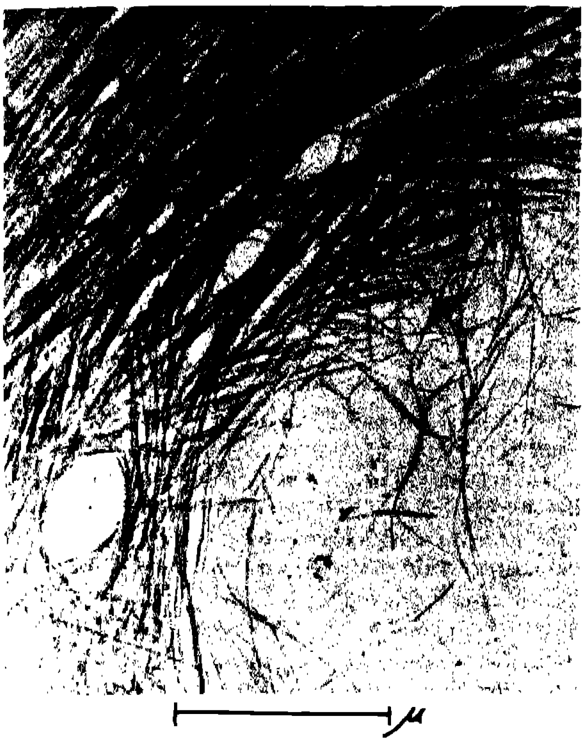

FIG. 6. Electron micrograph of a 72-hour specimen of V_2O_5, showing negative tactoids, × 28,000.

ground which can be recognized in Fig. 2 despite the low magnification used. Such sheaves are observed also in electron micrographs obtained from the fresh juice of tobacco plants infected with tobacco mosaic virus (*7, 13*). The polarizing microscope has shown corresponding structures in original undried specimens only if typical tactoids fail to develop. Such sheaves of tactosol do not have a well-defined boundary towards the atactosol, but they generally extend over areas at least the order of magnitude of normal tactoids. These sheaves may be structural intermediates between typical tactoids and the structures to be discussed presently.

TABLE 2

AXIAL RATIOS OF POSITIVE AND NEGATIVE TACTOIDS
(From electron micrographs)

Type	Number measured	Range of the major axis in microns	a/b
Positive	27	2.2 to 14.0	5.01 to 2.75
Negative	6	0.2 to 0.6	4.0 to 1.6

Wyckoff (*14*), working with purified tobacco mosaic virus protein, shows gold shadow-cast electron micrographs of frozen-dried specimens in which sheaf formation and stratified background are indicated somewhat similarly. The meshes observed in frozen, dried preparations were interpreted as negative tactoids (see below); but discrete, positive tactoids, which are illustrated in the present work, were not observed.

Forty-eight hours after preparation extensive anisotropic regions of tactosol are observed in the light microscope, interspersed with elliptical holes filled with atactosol. These holes, first observed by Zocher and Jacobsohn and named "negative" tactoids (*1*) are preserved during drying of the specimens (Fig. 6). The range of their axial ratios is similar to but less than that of the "positive" tactoids as shown in Table 2.

Prior to drying, these anisotropic structures are characterized under the polarizing microscope by a parallel orientation of the individual crystals with respect to the differential symmetry axis of the volume element. In contradistinction to a positive tactoid, there is no symmetry axis for the entire structure. Instead, the differential symmetry axis curves or suddenly changes direction. Except for minor artifacts and structural distortions, the electron micrograph is in agreement with the evidence obtained from double refraction. The electron micrograph clearly shows a transition of the tactosol towards a curving and occasionally interlacing fibrous structure. At the higher magnification of × 120,000 it is found that the individual fibers have a width of 65 A or less. Such fiber structures of V_2O_5 exhibit a positive double refraction, and since the individual crystals also exhibit this, it follows that the fibers must have a nematic structure.

This trend towards a fibrous structure is accentuated with further aging, as is shown in electron micro-

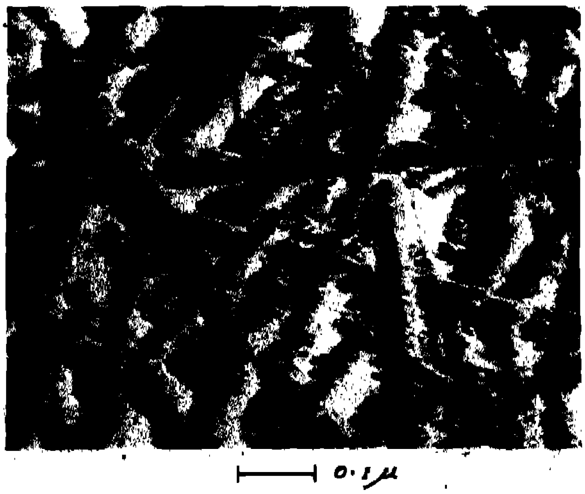

FIG. 7. Electron micrograph of a shadow-cast, 30-day sample, which shows the transverse structure in the rod-like crystals, × 120,000.

graphs obtained from the tactophase after aging for 30 days (Fig. 7). The equivalent in the polarizing microscope is a mosaic pattern of birefringent areas whose size is below the resolving power of the microscope. The electron micrographs agree with this basic type of structure in the sol.

As to the other interesting details brought out with high magnification and shadow casting in Fig. 7, it is not possible at the present time to decide whether these are characteristic for the dried specimens alone or also for the originals. The outstanding characteristic of these details is a transverse structure, particularly at the arrow. In the shadowgram this structure is repeating, with ridges 65 A wide and intervening valleys 35 A wide. Perpendicular to these dimensions, the average width of the fibers themselves is 300–400 A. The width of the ridges is compatible with the length to be expected from the data in Table 1 for the individual V_2O_5 crystals in sols of this age. On this hypothesis, each ridge defines an array of crystalline particles oriented parallel to each other and also, though with considerable less regularity, parallel to the fiber axis. An orientation of the crystal rods perpendicular to the fiber axis, assuming that the rods have a length of 300–400 A, is less likely but is not to be excluded. The possibility that the fine structure of Fig. 7 may not be representative of the original structures in the liquid medium imposes even more reservations upon a tempting further comparison between this transverse structure and the fine structure of collagen fibers, shown by electronmicroscope (*9*).

A freshly prepared solution of V_2O_5 is known to exhibit Newtonian flow. On aging, anomalous (elastic) flow is observed. Finally, the tactophase acquires the typical consistency of a gel-phase. These rheological changes, which accompany and are the result of the development and subsequent transformation of the anisotropic structures discussed, add further support to the concept that tactoids (geloids) may be the primary elements responsible for gel formation, at least in those systems where no chemical cross-linking occurs (*5*).

In conclusion, it is worth pointing out that no effects of electron bombardment upon any of these specimens were noted even under a biased gun at high intensity. This contrasts with the observations published earlier concerning the effects of electron bombardment upon "young" elliptical particles which form the elements of smectic tactoids of WO_3 (*12*), and also removes any possibility that the structures reported here are pseudostructures introduced by electron bombardment (*11*).

[*This work was supported in part by a grant of the Research Corporation to Wayne University.*]

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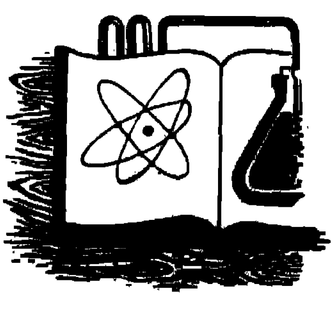

TECHNICAL PAPERS

Alleviation of Experimental Diabetes in Man by Administration of Reduced Glutathione (GSH): Metabolic Implications[1]

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It has been reported from this laboratory (*1, 3*) that a state of metabolism similar to that observed in clinical diabetes mellitus can be produced in normal men and women by the administration of suitable amounts of purified preparations of pituitary adrenocorticotropic hormone (ACTH). The condition produced is characterized by sustained glycosuria and hyperglycemia, glucose tolerance curves characteristic of the diabetic state, and relative resistance to the hypoglycemic effect of exogenous insulin. During administration of ACTH the developing diabetic state is accompanied by a decreasing concentration of blood glutathione (*2*). Because of a temporally related upheaval of purine metabolism (the precise nature of which remains unknown) which is manifested by a sustained increase of urinary uric acid, we have hypothesized that a purine metabolite, exerting an alloxan-like effect, is responsible for reducing the intracellular availability of free sulfhydryl (—SH) groups, which are necessary for normal activity of many enzyme systems; that the combination of decreased intracellular concentrations of —SH and increased intracellular concentrations of purine metabolites impairs functional activity of the insulin-producing cells of the pancreas (the product of which is a protein rich in cystine) and also interferes with peripheral glucose utilization by inhibition of those enzyme systems which require free —SH groups.

In addition to hyperglycemia, and contributing to the degree of glycosuria, is the effect of ACTH in decreasing renal tubular reabsorption of glucose. This easily followed phenomenon can be assigned with reasonable justification to inhibition of an enzyme within the tubular epithelium.

An extensive metabolic balance study (30 days) was made upon a normal young man to determine whether or not large amounts of GSH administered intravenously would reverse (despite continued ACTH administration) an already established hyperglycemia and glycosuria. After an 8-day base-line period, ACTH[3] (68 mg/day, Armour Standard) was given in equal doses every 6 hrs for the following 6 days. On the fourth day of ACTH, pure reduced glutathione (buffered to neutrality and put in solution and into sealed glass containers under nitrogen) was given intravenously in the following amounts: 8 gm at 8 a. m., 4 gm at 1 p. m. and 4 gm at 2 p. m. On the sixth day of ACTH, 4 gm more of GSH were given at 2 p. m. The post-ACTH balance study was continued for the next 16 days. In addition to 24-hr balances throughout, blood specimens were obtained hourly from 8 a. m. to 4 p. m. daily, and urine specimens were collected every 2 hrs from 8 a. m. to 4 p. m. for 11 consecutive days which included the 6-day ACTH period. A large number of determinations other than those relating to carbohydrate metabolism were made upon these samples.

TABLE 1

Day of ACTH	1	2	3	GSH* (4)	5	6
Fasting blood sugar (mg/100 cc)	71	78	108	124	134	148
Blood sugar—average of 9 a. m., 2 p. m., 3 p. m. (mg/100 cc) .	115	165	184	*157*	204	193†
Urine sugar - 8 a. m.–4 p. m. (gms)	1.0	5.1	14.7	*4.0*	10.2	24.8

* GSH: administered at 8 a. m., 1 p. m., and 2 p. m. on day No. 4.

† Values for this average are 108 at 9 a. m.; 201 at 2 p. m.; and 170 at 3 p. m. GSH administered once on this day at 2 p. m.

Renal glycosuria occurred on the first day of ACTH. Hyperglycemia became evident on the second day and continued with increasing intensity through the entire ACTH period *except during the intervals when GSH was administered.* The reversal was dramatic but transitory, lasting 1–2 hrs after each injection of GSH. Most striking were (1) sharp elevation of the renal threshold for glucose and (2) a fall of the blood sugar level. These phenomena resulted in glucose-free urine during each hour immediately following administration of GSH. Table 1 summarizes the influence of GSH

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[1] This work represents part of a project financed by the Research Grants and Fellowships Division of the U. S. Public Health Service.

[2] We wish to acknowledge the valuable assistance of Frank H. Bethell, assistant director of the Simpson Memorial Institute, in the performance and interpretation of the hematological studies.

[3] We are indebted to John R. Mote, The Armour Laboratories, Chicago, Illinois, for the purified ACTH used in these studies.

[4] Both blood and urine glucose were determined by the Somogyi procedure as modified by Nelson (*5*).

(during its effective period) upon glycosuria and hyperglycemia produced by ACTH.[4]

The effect of GSH in simultaneously reversing ACTH-induced hyperglycemia and renal glycosuria seems all the more striking since sudden cessation of glycosuria would be expected to result in further increase of hyperglycemia were the rate of utilization of glucose not significantly increased or the supply to the blood significantly decreased. Since a severe degree of negative nitrogen balance remained uninfluenced by GSH, decreased glyconeogenesis from protein was probably not a factor. That hepatic glycogenolysis may have been inhibited remains as a possibility to explain the fall of blood sugar.

Since GSH inactivates insulin *in vitro*, such an effect *in vivo* should have raised the blood sugar level. If this occurred to any degree, its effect was minor as compared with those forces which produced an actual fall of circulating blood sugar.

Also observed were other metabolic reversals of major significance. Among the most striking was a profound change in the number and character of the circulating white blood cells. This remarkable change, which lasted 1–2 hrs, was opposite in direction to the effects which we have observed repeatedly in normal people receiving ACTH for a number of days (*4*). These findings are being reported in detail elsewhere.

Not all of the metabolic effects of increased adrenal corticoid activity were reversed by administration of GSH. This indicates that reversal of those metabolic effects which responded to GSH was not by virtue of a block in steroid production. It seems likely that the changes are due to improved performance of those systems which require free sulfhydryl groups for their normal function. This appears to be the case with respect to (1) renal tubular reabsorption of glucose, (2) the systems involved in utilization of glucose, and (3) the systems responsible for production and release of white blood cells.

It is believed that the results reported give added weight to our hypothesis. The forces at work in the early stages of the development of human diabetes may be very similar to those described in this and in our previous studies. Of somewhat broader significance are the implications with respect to abnormalities of metabolism generally. Hormonal control of enzymatic processes, mediated via independent effects of the same hormone upon other systems, appears to be a fertile field for future investigations. But it implies the necessity of establishing technics which can be applied in the intact animal or man.

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Production of Acute Gouty Arthritis by Adrenocorticotropin[1]

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It has long been known that attacks of acute gouty arthritis can be precipitated by exposure to nonspecific stresses such as trauma, infection, operation, chilling, foreign protein therapy, X-radiation, and many other stimuli. These stresses have been shown to produce a syndrome of increased adrenal cortical activity (*5*) and associated biochemical and histologic changes, commonly referred to as "the alarm reaction" (*4*).

It is likely that all forms of nonspecific stress call forth increased adrenal cortical activity through a common pathway. This pathway is increased secretion of pituitary adrenocorticotropin (ACTH), which in turn stimulates the adrenal cortex (*4*).

ACTH has therefore been given to four patients with gout and has precipitated three attacks of acute gouty arthritis in five trials. The entire syndrome of electrolyte and water changes observed to occur with the acute attack of gout (*3*) has also been reproduced by the administration of ACTH.

In addition, since it was shown that the attack of gout follows a phase of relatively decreased adrenal cortical activity, the administration of ACTH to two patients during an attack of acute gouty arthritis produced a *prompt disappearance of the acute arthritis.* This aspect of the action of ACTH resembles that of colchicine, which relieves the acute attack of gout and is a potent stimulus to increased adrenal activity (*2*).

Three of the four patients were studied on a metabolic ward and received diets of known composition. After a control period of four days, 150 mg (equivalent to Armour standard) ACTH[3] was given by intramuscular injection each day in divided doses for four days.

Control serum uric acid was elevated in all patients. During the administration of ACTH, there was an increase in urinary uric acid and nitrogen and a decrease in sodium and chloride excretion. Three patients had glycosuria of one to three gm daily. In two patients, there was a significant increase in glomerular filtration rate, renal plasma flow, and uric acid clearance (*1*). The circulating eosinophils disappeared while ACTH was being given.

For three days following completion of the ACTH injections, there was an excretion of sodium and chloride considerably greater than the control values while the uric acid excretion returned to the control value. The increased electrolyte excretions may be interpreted as a phase of decreased adrenal cortical activity due to withdrawal of the ACTH.

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[3] Supplied by The Armour Laboratories through the kindness of Dr. John R. Mote, Medical Director.

The attacks of acute gouty arthritis began during the third and fourth days of the postinjection period, when the electrolyte and water diuresis was almost completed. Each attack resembled the classic picture of acute monoarticular arthritis. The two patients who did not develop acute arthritis nevertheless exhibited similar changes in urinary excretion during and following the administration of ACTH. This sequence of electrolyte changes in gouty patients has previously been described as "the gout cycle" (*6*).

In two attacks, one of which had been provoked by ACTH and the other by a mercurial diuretic, 200 mg ACTH given over a 36-hour period starting on the first day of the attack was followed by a disappearance of joint signs within 48 hours after the injections were completed. Untreated attacks of acute arthritis in these patients had previously lasted 10 to 14 days. The increased electrolyte excretion following the mercurial diuretic mimics "the gout cycle" and in this manner may be involved in precipitating the attack of acute arthritis.

The results suggest that stimulation of adrenal cortical function is the common pathway in the precipitation of acute gouty arthritis by nonspecific stress and that pituitary adrenocorticotropin may be useful as a provocative and therapeutic agent in gout.

Since this work was completed, similar results have been reported in one patient (*3*).

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A Simple Method for Welding Thermocouples

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The use of thermocouples in physiological problems, for such purposes as recording respiration or blood flow, necessitates the use of very small wires which often are very difficult to solder or braze by conventional methods. Furthermore, the sensitivity of the thermocouple is dependent on the type of joint, for a large juncture allows local currents of considerable magnitude to flow, thus reducing the effective voltage output. The introduction of foreign metals in the soldering or brazing process sets up contact electromotive forces with the same deleterious effects.

These metals may be welded, however, by the method to be presented here. The materials necessary are shown in Fig. 1. It is simply a metal cup containing a few millimeters of mercury under about 2–3 cm of oil. Mineral oil or 10–30W motor oil may be used. In the apparatus now in use in this laboratory, the cup consists of the inverted metal shell of a vacuum tube with a grid cap (6J7). The cup is connected to one side of the d-c main, and the thermocouple wires to the other side through a series resistor as shown. The thermocouple is then moved down to touch the surface of the mercury and withdrawn. Welding is accomplished by heat from the arc formed at the moment of contact with the mercury. A "buzz" accompanied by slight boiling in the oil layer signifies good contact. The size of the series resistor depends on the size of the wires to be welded, as a larger current will be required for larger wires. We use a 400-w heating element for 0.3-mm iron-constantan couples. A little experimentation will quickly show the optimum value of current, as too much current causes burning of the wires with a large junction, and too little current does not weld at all.

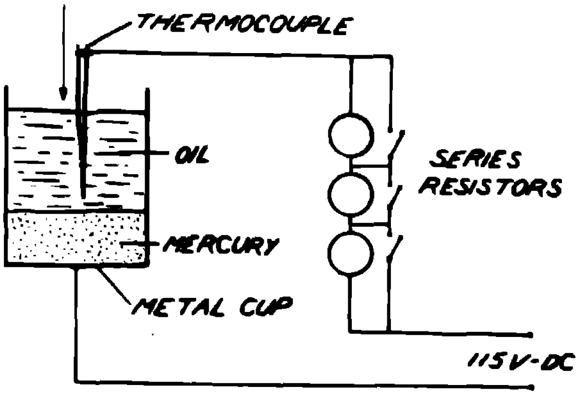

FIG-1

The method of preparing the wires for welding is as follows: They are first twisted tightly together for a distance of several millimeters; the distal end of the twisted junction is then cut off so that only a turn or so remains. The wires are now ready to weld, and after welding they may be untwisted if any of the twisted portion remains unfused, so that the wires are joined only by a small ball of fused metal. This ball should be as small as possible, without sacrificing the strength of the joint.

This method has been utilized with iron-constantan, platinum-platinum-rhodium, chromel-alumel, and copper-constantan couples, with wire sizes from 0.1 mm to 4 mm. A larger cup with more and heavier oil is required for the larger wires. The circuit should be fused in all cases.

Secretion of Radioactive Calcium in the Hen's Egg[1]

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The availability of pile-produced Ca^{45} has facilitated investigation of the economically and fundamentally important problem of the secretion of this element in the hen's egg. Approximately 1 mg of calcium as a solution of the chloride, with an activity of 15 µc, was administered into the lower esophagus of the fasted bird. For a period of 20 days after dosage, each egg laid was analyzed for total calcium and Ca^{45} uptake in the yolk, white, and shell.

The entire yolk was wet ashed with concentrated HNO_3, the solution evaporated to near dryness, the fat removed with ether, and the dried residue ashed at 750° C for 8 hrs; the ash was dissolved in dilute HCl and the calcium precipitated as the oxalate (*2*). The white was treated similarly, except that the ether extraction was omitted. The shell was wet ashed in concentrated HNO_3, the solution evaporated to near dryness and prepared directly for the oxalate precipitation step. The calcium oxalate was collected on filter paper over a uniform area for measurement of total calcium by weight and of radioactivity with a thin mica-window Geiger counter (*1*). Self-absorption and decay corrections were made in the usual manner.

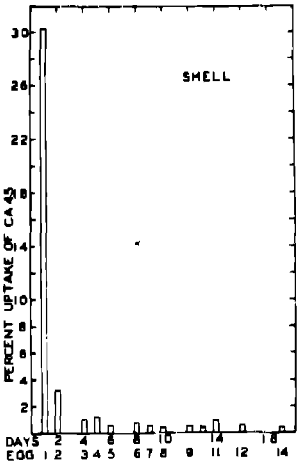

FIG. 1. Percentage of Ca^{45}, fed as a single dose, appearing in shell of successive eggs.

Single dosage studies were made with two birds and a multiple feeding trial with another; the results were in fair enough agreement, so that for clarity data from only one bird are presented. Fig. 1 shows the percentage uptake of administered Ca^{45} in the shells of the successive eggs. In an egg laid 15 min after dosage, the shell contained a detectable amount of the labeled calcium representing 0.07% of the dose. It was observed that the shell of the 24-hr egg contained 30–35% of the dosage, the values thereafter falling sharply and leveling off at about 0.5%. It is considered from the time factor and the constancy of the values that the labeled calcium found in the shells after the fourth day reached there via the body stores.

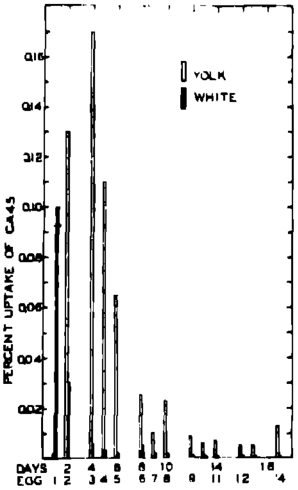

FIG. 2. Percentage of Ca^{45}, fed as a single dose, appearing in yolk and white of successive eggs.

Fig. 2 shows the percentage uptake of administered Ca^{45} in the yolk and white of successive eggs. No labeled calcium was detected in the yolk and white of an egg laid 15 min after dosage. In the 24-hr egg it was noted that the white contained about 70 times as much Ca^{45} as did the yolk, which probably reflects the prior maturity of the latter. The situation was reversed in the egg laid at 48 hrs, and thereafter the yolk always showed a somewhat greater accumulation of labeled calcium than did the white. The total percentage accumulations in the yolks, whites, and shells of the 14 eggs collected after dosage were 0.7, 0.2, and 40, respectively. This emphasizes the ability of the hen to incorporate a large percentage of the ingested soluble calcium into the shell of the egg. It was calculated from the total dietary calcium intake and output in the eggs and the reported data that a maximum of from 60 to 75% of the calcium in the egg reached there directly from the ingested calcium, the remainder probably being drawn from the body stores. Bone analysis at the termination of the experiment indicated that considerable skeletal storage had occurred; the left pubis contained about 1 µg of labeled calcium/gm of bone. About 0.005% of the dose was found in the blood at termination.

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[1] Published with the permission of the director of the Florida Agricultural Experiment Station. The Ca^{45} was obtained from the Oak Ridge National Laboratory on allocation from the Atomic Energy Commission.

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Statistical Data on Glacial Boulders[1]

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While doing field work in the James River area in eastern South Dakota and in the Crosby-Minot area in northwestern North Dakota, both of which areas are covered by glacial drift, the writer recorded the distribution of boulders as a help in mapping small moraines that might have a significant relation to the occurrence of shallow ground-water supplies.

There are, of course, many more small boulders than large ones. The total number in each area examined was too great to be easily recorded, but all boulders noted that were 4′ long or longer were measured. On grouping the measurements into half-foot sizes it was found, as could be expected, that the number in each group increased rapidly with the decrease in size. For boulders between about 4′ and 9′ in length the rate of change seemed to follow nearly a mathematical sequence. The number of boulders more than 9′ in length was too small to form groups showing such a regular change. J. B. Mortie, Jr., considers that, within the size limits measured, the data suggest some logarithmic law of distribution (written communication). When plotted on semilogarithmic paper the numbers lay nearly along a straight line, as shown in Fig. 1. The rate of increase seems to be nearly the same in each of the two areas examined, as the plotted lines are nearly parallel. Partial calculations have indicated that size-groups based on the product of the three principal dimensions of the boulders would give a similar mathematical series; perhaps because the great majority of the boulders are of approximately the same shape, being roughly oval in both transverse and longitudinal cross sections.

The average number of boulders 4′ long or longer to the square mile is nearly twice as great in the James River area as in the Crosby-Minot area. In the James River area, however, boulders less than 4′ long are not very plentiful, and piles of cobbles are uncommon; whereas in the Crosby-Minot area small boulders and great piles of cobbles in the fields and road corners are very common. An attempt to extrapolate from the observed data, in order to estimate the number of boulders 2′–4′ in length that might be available for riprap on irrigation works, seemed to be of doubtful value because of the scarcity of small boulders in the James River area and the rapid increase in their number with decrease in size in the Crosby-Minot area. In the latter area, the tendency for the number to increase more rapidly with smaller size may be indicated by the 825 boulders 4.0′ to 4.4′ long that were noted, as this number is greater than it should be to accord with the number in the larger size groups.

R. F. Flint has found that in glaciated areas the proportion of large boulders increases as the age of the drift decreases and that this seems to hold true from the Nebraskan through the late Wisconsin drift. He has also found that deeply weathered boulders are usually associated with the earlier ages of drift (written communication). The distribution of boulders in parts of Ohio was recorded by R. P. Goldthwait as a help in tracing minor moraines (oral communication).

Studies of glacial drift, based on the percentages of pebbles of different sizes in the gravels, have been made; but the writer has not learned of any statistical studies that may have been made on the number of boulders of different size-groups in areas of glacial drift. However, studies of similar logarithmic sequence in the sizes of crushed materials have been made by Austin (*1*), who mentions that the mathematical data may be applicable to the determination of concrete aggregates; by Roller (*3*); and by Epstein (*2*), who has applied them to the sizing of coke. The mathematical sequences present in many natural phenomena have been commented on by Sawyer (*4*), who states: "It is indeed remarkable how much of the physical world, amid the conflicting action

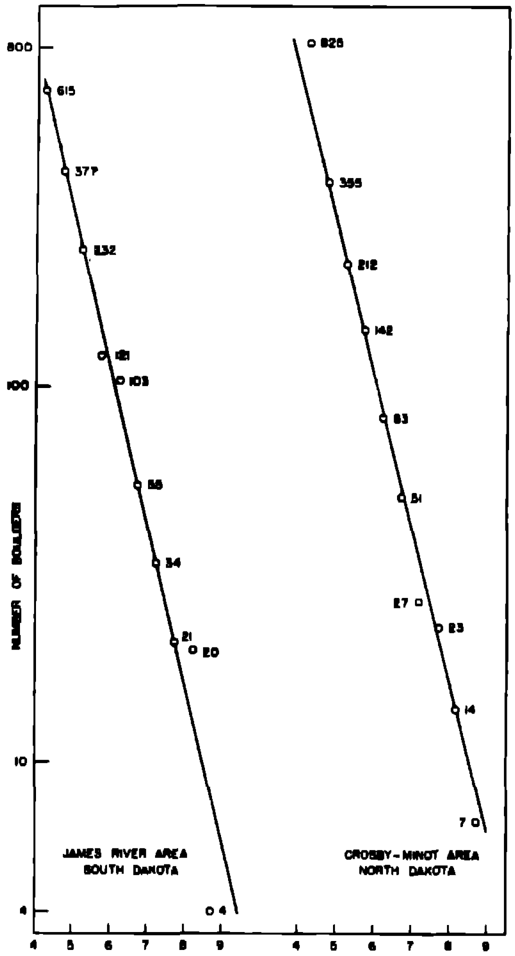

FIG. 1. Number of glacial boulders of different size-groups in areas in South Dakota and North Dakota.

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[1] Published by permission of the director, U. S. Geological Survey, Washington, D. C.

of a great variety of unconnected forces, can be described by the simplest mathematical function, x^n and e^x.''

TABLE 1

Sizes of glacial boulders

Boulder length (feet)	James River area*	Crosby-Minot area†
4.0 to 4.4	615	825
4.5 " 4.9	377	355
5.0 " 5.4	232	212
5.5 " 5.9	121	142
6.0 " 6.4	103	83
6.5 " 6.9	55	51
7.0 " 7.4	34	27
7.5 " 7.9	21	23
8.0 " 8.4	20	14
8.5 " 8.9	4	7
9.0	8	
9.1		4
9.2		1
9.3		1
9.5	6	5
9.6	1	
10.0	7	1
10.2	1	
10.5	2	3
10.7	1	
10.8		1
11.0	1	
11.2		3
11.3		1
11.6		1
12.0	1	
13.0	2	1
13.5	1	1
15.0	1	
17.0	1	1
Totals	1,615	1,763

Rock types of glacial boulders

	James River area		Crosby-Minot area	
	Number of boulders	Percent of total	Number of boulders	Percent of total
Granite	1,481	91.7	1,084	61.5
Granitic gneiss	54	3.3	476	27.0
Very hard hornblende-biotite gneiss	40	2.5	43	2.4
Garnet schist			14	0.8
Paleozoic limestone	30	1.8	99	5.6
Very hard siliceous sandstone			32	1.8
Basic igneous rock	1	0.7	8	0.9
Greenstone	7			
Tertiary sandstone (Fort Union form)	2		7	
Totals	1,615	100.0	1,763	100.0

* James River area, 1,170 square miles examined; average, 1 boulder to 0.73 square mile.

† Crosby-Minot area, 2,600 square miles examined; average, 1 boulder to 1.47 square miles.

More than 90% of the large boulders in each area are of granite, gneiss, and schist, and nearly all are of hard, unweathered rock. No large weathered boulders were seen in the Crosby-Minot area, but 10 large boulders of deeply weathered granite were recorded in the James River area. Table 1 shows the number of boulders of each size-group and the kinds of rock in each area.

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Characteristics of the Desoxycholate-treated Cytochrome Oxidase[1]

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In 1947 the authors reported the preparation and partial purification of a solubilized cytochrome oxidase (*9*). This article is concerned with its further characteristics and the methods employed in an attempt to purify the desoxycholate-treated cytochrome oxidase.

Physical appearance: The insoluble cytochrome oxidase complex (*1*, *5*) is tan, opaque, and particulate in appearance. A partially purified preparation (2-3%), made as previously described (*10*), is clear to the naked eye and light yellow in color.

Lyophilization: All of the desoxycholate-treated oxidase preparations reported in this and in previous papers may be lyophilized from the frozen state and stored at 0° without loss of activity.

Variations in Q_{O_2} protein: The partially purified preparations from lamb heart vary in their activity by as much as 35%, having Q_{O_2} protein values ranging from 1,500 to above 2,000 when tested with the hydroquinone system previously described (*10*). These variations may be ascribed in part, at least, to the amount of protein in the insoluble cytochrome oxidase suspension which seems to be directly related to the amount of sodium desoxycholate that must be used for the first extraction.

Gel formation: The preparation of the partially purified enzyme is often made difficult by the formation of a gel. This gelation seems to be a property of the desoxycholate when dissolved in phosphate buffer (*7*, *8*). The oxidase activity is not impaired, however. If the final supernatant is left to stand at 0°, it will invariably gel. This gel may be liquefied by simply warming the tube in the hand.

Denaturation on standing: A partially purified preparation (1.5-3%) has been kept at 0° in both the concentrated form (gelled) and diluted form for 6 days without loss of activity. When tested on the tenth day, after bacterial contamination was marked, the concentrated preparation showed no loss in activity and the dilute preparation a 30% loss.

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[1] Aided by a grant from the John and Mary R. Markle Foundation.

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[3] Present address: Bureau of Biological Research, Rutgers University, New Brunswick, New Jersey.

In view of the loss in activity of the insoluble cytochrome oxidase complex when tested in a system involving the oxidation of D-glucose by added D-glucose dehydrogenase protein, diphosphopyridine nucleotide, and cytochrome C (*3*), it is particularly interesting to note that the insoluble oxidase preparations discussed above showed no significant loss in activity in 13 days when tested with the hydroquinone system. These observations suggest that a factor is destroyed in the aging of the insoluble cytochrome oxidase complex which is necessary for the oxidation of D-glucose by the previously mentioned system, but which is not required for the oxidation of hydroquinone.

TABLE 1

Temperature (°C)	Q_{O_2} protein	Loss in activity (%)
Unheated	2180	. . .
40	1150	53
45	710	67
50	460	79
55	150	93
60	0	100

Heat stability: Table 1 shows the destruction of enzymatic activity at a relatively low temperature. There was no visible precipitate in any of the tubes after the partially purified and diluted (1: 25) preparation (2–3%) had been heated for 5 min at the temperatures noted. The tests were made as previously indicated (*10*), except that semicarbazide (0.3 ml of a 0.1 M solution) was used as a ketone fixative.

In another experiment, neither the insoluble nor the partially purified preparation suffered any loss in activity after being heated for ½ hour at 37°.

pH optimum: Preliminary experiments indicate that the oxidation of reduced cytochrome C by a partially purified, lyophilized preparation (2–3%) occurs most rapidly at pH 7. The 0.05 M buffers used and their pH values are as follows: acetate, pH 5.04; phosphate, pH 7.0; phosphate, pH 7.95; borate, pH 8.8; glycine, pH 11.05.

The methods used in an attempt to purify the oxidase are as follows:

Dialysis: Dialysis for 18 or 24 hrs does not significantly alter the activity. However, in an experiment where a 1.5–3% preparation was used in both the concentrated and the dilute (1: 25) form, there was a considerable precipitate at the end of 3 days of dialysis (the water being changed each day) and the preparation was inactive. A crude test showed little or no desoxycholate to be present. Added desoxycholate dissolved the precipitate but did not restore the activity.

Other experiments indicate that it may be possible to remove the desoxycholate without too great a loss in activity by dialyzing against 0.01 M KH_2PO_4–Na_2HPO_4 buffer of pH 7.4 or above. This is being further investigated.

Centrifugation: In 1944, Haas (*4*) reported the separation of his cytochrome oxidase preparation into 2 components by centrifugation at 10,000 rpm for 2 hrs. This separation has been reviewed by Keilin and Hartree (*6*). Our experiments demonstrate that even the dilute preparations (1: 25) can be centrifuged at 20,000 × g for 2 hrs without any indication of a separation of components.

Effect of pH: The pH of our partially purified preparation (1.5–2%) is approximately 8. By gradually lowering the pH of a diluted sample with HCl, we find that at pH 6.2 the activity is still in the supernatant (slight precipitate removed), while at pH 5.78 the partially inactivated enzymes are in the precipitate together with the desoxycholate.

Use of alcohol: A 0–4% preparation can be partially purified by fractional precipitation with ethyl alcohol. Preliminary experiments on a lyophilized, partially purified preparation (1.5–2%) show that no visible precipitate forms with as much as 80% of alcohol at 0°. This concentration of alcohol completely destroys the oxidase.

Effect of ether: It was assumed, as previously suggested (*10*), that the oxidase complex might be a lipoprotein. An attempt was made to separate the lipoidal component by the use of ethyl ether. The activity of a partially purified oxidase (1.5–2%) was completely destroyed by washing with ether.

Preferential solubility in sodium desoxycholate: It has been shown (*10*) that the addition of a small amount of desoxycholate (1.5 or 2%) to the insoluble preparation dissolves proteins of low activity, whereas larger amounts of desoxycholate (3 or 4%) dissolve active proteins as well. It was on this observed differential solubility of the active and inactive proteins that the partial purification was based. It seemed possible also that the various components of the oxidase complex could be separated by successive additions of small amounts of desoxycholate. Favorable results have been obtained by the use of this method, and a preliminary report has been presented (*2*).

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The Analgesic Action of Teropterin[1]

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In 1947 Farber and his associates (*1*) indicated that teropterin, when administered to patients suffering from various forms of cancer, made it possible in some instances to reduce the amount of analgesia required. This indicated that teropterin possessed a certain amount of pain-relieving activity. Lehv, *et al* (*2*) stated categorically that "Our clinical observations indicate that the drug is nontoxic in the dosage given. Pain was relieved in most instances, if not all, by the use of teropterin. This obviated, in the main, the necessity for further use for opiates with their concomitant depressive effect."

These clinical observations on the analgesic property of teropterin were of interest in our laboratory, and we decided to prove or disprove the pure pain-relieving activity of this drug.

Twelve experiments on premedical students were performed, using a modified Wolff-Hardy-Goodell technique. Each one of the subjects received a 20-mg dose of teropterin injected intramuscularly. Neither the operator of the pain threshold apparatus nor the subject was cognizant of the nature of the drug that was injected, since all doses were administered by a third individual.

A definite rise in the pain threshold response was observed 15 min following the injection of 20 mg of teropterin. On an average, the peak of the effects were reached in 70 min and lasted for 135 min. Teropterin produced a 6.6% rise in pain threshold when the peak of the effects were reached. In each instance the experimental data showed that the effects were always in the same direction. This fact made it clear to us that teropterin was actually producing a true analgesic effect.

The results on 12 subjects definitely indicate that teropterin causes analgesia as interpreted by a rise in pain threshold in man. This confirms the clinical observations thus far reported. Contrary to the sense of well-being and some slight euphoria as was noted in those patients with cancer who received teropterin, we did not observe any of these effects. Nausea and other subjective symptoms were also lacking.

Teropterin possesses true analgesic action when tested on the normal human subject. This activity should be of value in reducing the amount of sedation needed when teropterin is used clinically.

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[1] Teropterin was kindly furnished by the Lederle Company, Pearl River, New York.

Flow in a Thin Glass Capillary as Affected by Wetting the Exterior of the Capillary[1]

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A review of pertinent literature has revealed widespread evidence that the outermost monolayer of molecules at the phase boundary of a liquid induces an orientation extending into the body of the liquid for many molecular lengths (*1*). The most reliable examples involve a range of orientation from a few tens of Angstrom units to a few thousand. The experiments of Nutting (*3*), however, pointed to an immobile layer of much greater depth.

Nutting found that the flow of crude petroleum oil through a narrow thin-walled glass capillary was appreciably slowed (6.8%) when the *outside* of the capillary was surrounded with water. He accounted for this by postulating an immobile layer of oil on the inside of the tube no less than 65,000 A thick. Kaminski, working in these laboratories and following the method outlined by Nutting, obtained comparable results (*2*).

It was apparent, however, that the effect could have been due to variations in temperature, since the temperature coefficient of viscosity of the medicinal paraffin oil used by Kaminski was such that the flow would have increased 7%/°C. Nutting's effect could be accounted for by the oil's being a degree warmer when not surrounded by water, and Kaminski's could be accounted for similarly by variations of a degree or two. This might well have occurred if the apparatus or the oil had been exposed to radiant energy during a measurement, or if the room temperature had risen just before a measurement. The particularly marked retardation in the flow of crude petroleum reported by Nutting and confirmed by Kaminski might thus be explained by the strong absorption this oil shows in the near infrared. Either of these variations would have warmed the dry capillary or reservoir of oil more rapidly than the capillary surrounded by a relatively large mass of water, and would then have led to a faster flow in the dry tube than in the wet.

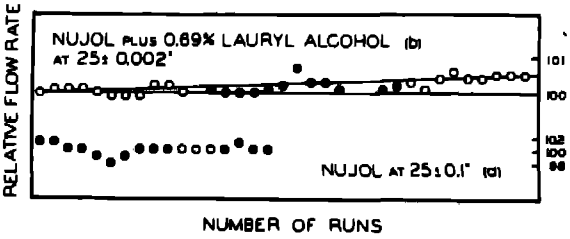

FIG. 1. Relative flow rate plotted against the number of passes through the capillary in (a) Series 1, and (b) Series 3. Open circles refer to passes when the outside of the capillary was dry; solid circles when the capillary was surrounded by water.

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[1] This work was done under contract between the Office of Naval Research and Stanford Research Institute.

Series 1: In order to evaluate the effect of temperature variations, Kaminski's apparatus was transferred to an air thermostat whose temperature varied less than 0.1°. It seems most unlikely that moving the apparatus into the thermostat could have changed any condition other than temperature, which may have been responsible for the Nutting effect observed by Kaminski. Deviations in flow rate up to 1.5% from the mean value were observed, but they showed no discernible consistent change after the capillary had been immersed in distilled water overnight, or after it had been allowed to dry out again for 3 days. The data are plotted in Fig. 1a.

Series 2: A more precise control of temperature was obtained by immersing the jacket containing a capillary in a water thermostat at 25° ± 0.002°. The internal diameter of this capillary was 0.747 mm. In these experiments, the capillary was made part of a U-tube, enlarged at one point to form a small reservoir, in the manner of an Ostwald viscosimeter. Great care was taken to eliminate possible surface active impurities. The entire apparatus was flamed to incipient fusion while a current of dried filtered air was passed through it. Both entrance tubes were bent downwards and guarded by plugs of glass fiber. The Nujol had stood with 10 per cent of its weight of Florisil (an activated silica) for a week with occasional shaking, and was centrifuged before use.

Thirteen runs were made in the dry capillary, 9 after filling the jacket with water, followed by 5 more after drying again. The flow times varied within 0.4% of the mean value (between 360 and 363 sec) with no indication of a consistent increase during the period of wetting. The experimental errors were magnified somewhat by an uncertain drainage of the measuring reservoir, which was below the capillary in this apparatus.

Series 3: Since a small percentage of a polar long-chain compound might produce an oriented immobile layer under conditions where a nonpolar oil would not, lauryl alcohol was added to make a 0.69% solution. (The Nujol wetted the glass, the lauryl alcohol solution did not.) The flow times relative to the first value, plotted against the number of runs, are shown in the upper plot (Fig. 1b). The radius of the circle represents probable errors in the timing, but does not take into account the variable drainage of the tube. It will be seen that any retardation that may have occurred on wetting the outside of the capillary is less than the random fluctuations (about 0.5%). A small but definite retardation with time of about 0.5% may be seen, however. The film thickness necessary to account for this would be about 0.9 μ, instead of 6.5 μ, which although still high, is more nearly in accord with the observations of others in this general field. It may also be due at least in part to slight clogging of the capillary by traces of suspended matter.

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Paper Chromatography of Flavonoid Pigments[1]

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Although the use of classical chromatographic adsorption methods for the separation of flavonoid pigments from plant extracts has been reported previously (*3, 4, 5*), such methods have not been successful in the separation of microquantities of these compounds. In a search for better methods of examining plant extracts for flavonoid pigments, we have applied the method of paper partition chromatography (*2*) to the problem. This preliminary report deals with the determination of R_f values for 11 flavonoid pigments in chloroform, ethyl acetate, phenol, and n-butanol-acetic acid; the separation of mixtures containing four to six of these pigments; and the use of color developing sprays to locate and identify the pigment zones.

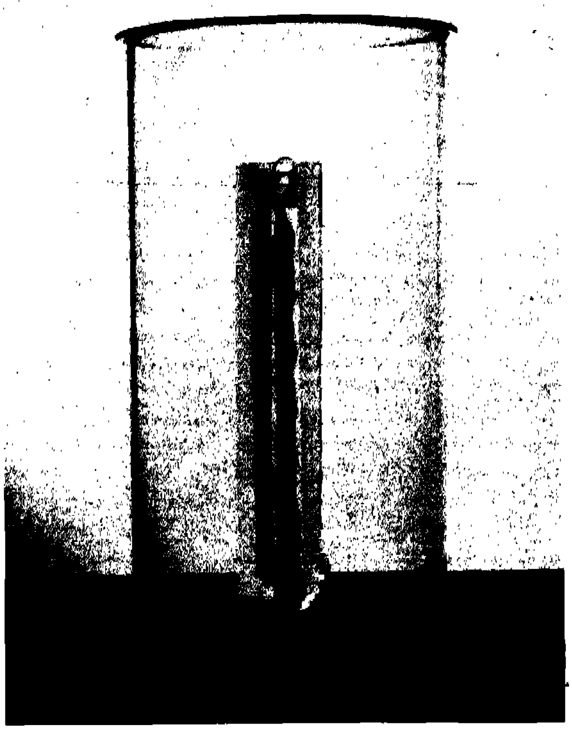

FIG. 1.

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[1] This investigation was supported by a research grant from the Division of Research Grants and Fellowships of the National Institutes of Health, U. S. Public Health Service. The samples of isoquercitrin, robinin, and kaempferol were kindly donated by the Pharmacology Laboratory, Bureau of Agricultural and Industrial Chemistry, Albany, California; the sample of naringin was donated by the California Fruit Growers Exchange, Research Department, Ontario, California. The other pigments were purchased from the S. B. Penick Company, New York City.

Several forms of one-dimensional apparatus have been tried during the course of this study. The one which served best (Fig. 1) was a modification of an apparatus recently described by Winsten (*6*). Discarded gasoline pump cylinders, 12″ in diameter by 26″ in height and closed at each end by a ground glass plate, served as vapor chambers. For troughs, 3″ Pyrex evaporating dishes have been used in place of the Petri dishes recommended by Winsten. From four to six strips can be accommodated at one time in the upper dish. A small glass stopper was used to hold the end of the strip in the solvent, and the weight of the wet strip prevented its touching the walls of the trough. This eliminated the danger of capillary siphoning without recourse to any special supports to hold the paper away from the inner and outer walls of the trough. The lower dish was fastened to a wooden base by means of stainless steel clips.

TABLE 1

Pigment	Fluorescence	R_f values			
		Ethyl acetate	Chloroform	Phenol	n-Butanol acetic acid
Quercitrin	Brown	.86	.05	.50	.83
Isoquercitrin	Dark brown	.64	.05	.58	.62
Rutin	Orange-brown	.17	.08	.42	.34
Robinin	Pale brown (turns to yellow-orange)	.17	.14	.23	.78
Naringin	Blue-white	.53	.15	.84	.50
Xanthorhamnin	Brown	.11	.06	.42	.25
Rhamnetin	Yellow	.06	.06	.25 .68	.87
Homoeriodictyol	None	.97	.87	.95	.97
Quercetin	Yellow	.03	.05	.82	.80
Kaempferol	Yellow	.06	.12 to .17	.70	.95
D-Catechin	None	.87	.11	.86	.78

Chromatograms of the individual pigments were prepared, using phenol, chloroform, ethyl acetate, and n-butanol-acetic acid. The first three of these solvents were saturated with water before use, and water, saturated with the appropriate solvent, was used in the lower trough. The three-component system n-butanol-acetic acid-water (40–10–50 vol.%) was used as the fourth solvent in a similar manner.

Whatman No. 1 filter paper, 47 × 57 cm, was cut into strips, 2.5 cm × 56 cm, by means of a power-driven paper cutter. The strips were spotted 8 cm from one end with 12–18 µl containing 7–10 µg of flavonoid pigment, and then allowed to air-dry prior to development of the chromatogram. Development was allowed to proceed until the solvent had traveled 30–40 cm. This required 8–22 hours, depending upon the rate of movement of the individual solvent. The strips were then air-dried and the pigment zones located by their fluorescence in ultraviolet light. The solvent front could also be located by this method, due to the fluorescence of impurities in the paper which traveled with the solvent front.

In the case of homoeriodictyol and D-catechin, neither of which fluoresces in ultraviolet light, it was necessary to spray the strip with a chromogenic reagent in order to locate the pigment zones. D-Catechin was located by spraying the strip with ammoniacal silver nitrate solution. The treated strip was then washed with distilled water and allowed to dry. Homoeriodictyol was located by spraying the strip with alcoholic ferric chloride solution (1%). With ferric chloride solution, homoeriodictyol forms a red-brown spot which is visible on the strip in concentrations as low as 10 µg.

The ratio of distance traveled by the pigment to distance traveled by the solvent (R_f value) is given in Table 1. The fluorescence of each pigment on the filter strip has also been included. The fluorescence of robinin changed from a pale brown to a yellow-orange color during the development of the chromatogram. This may have been due to a trace of impurity initially present and removed as development proceeded. Rhamnetin gives two zones when chromatographed with phenol.

TABLE 2

Pigment	Na_2CO_3		Alcoholic $AlCl_3$		Boric acid-Citric acid		n-Lead acetate		Basic lead acetate	
	a*	b*	a	b	a	b	a	b	"a"	"b"
Quercitrin	YB	YB	Y	Y	Y	Y	YB	OY	Y	O
Rutin	Y	OY	Y	OY	Y	Y	Y	OB	Y	O
Robinin	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Naringin	..	..	..	..	..	..	..	BlW	..	GY
Xanthorhamnin	Y	Y	Y	Y	Y	Y	YB	OY	Y	O
Rhamnetin	Y	Y	Y	GY	Y	Y	B	Y	B	O
Homoeriodictyol	..	..	..	..	..	..	..	..	..	..
Quercetin	YB	OB	Y	GY	Y	Y	B	OB	B	O
Kaempferol	Y	Y	Y	GY	Y	Y	Y	GY	Y	Y
D-Catechin	RB	B	..	..	..	..	B	Blk	Y	..
Isoquercitrin	Y	YB	Y	Y	Y	Y	YB	OY	Y	O

* Column a—color in ordinary light; column b—fluorescence in ultraviolet light; Y—yellow; B—brown; O—orange; G—green; W—white; Bl—blue; Blk—black; R—red; ..—none.

Mixtures of four to six pigments have been separated on a one-dimensional chromatogram strip by selecting the solvent giving the greatest differences in R_f values for the particular pigments. The R_f value is lowered slightly by the presence of other flavonoid pigments but the relative values appear constant.

The color of the pigment zones in ultraviolet light is an aid in identifying the respective pigments on the developed chromatogram. In addition, many of the usual qualitative color tests for flavones, flavonols, flavonones, and chalcones can be applied to the pigment zones on the strip. This is of advantage in determining whether a particular spot from a plant extract is of flavonoid character and, in addition, is also of value in the tentative identification of a particular flavonoid pigment. Such reagents include: sodium carbonate, ammonium hydroxide, alcoholic ferric chloride, alcoholic potassium hydroxide, alcoholic aluminum chloride, normal lead acetate, basic lead acetate, ammoniacal silver nitrate, antimony pentachloride in carbon tetrachloride, and boric acid-citric acid in acetone. The reaction products obtained by use of basic lead acetate, normal lead acetate, alcoholic aluminum chloride, sodium carbonate, and the boric acid-citric acid reagent give an intense fluorescence in ultraviolet light and the characteristic color test in ordinary light. This property has been used to locate and identify pigment zones on the developed chromatogram strips. Table 2 lists the visible and fluorescent colors obtained with the latter reagents.

By paper partition chromatography, coupled with the use of chromogenic sprays, one can quickly and easily obtain information as to the presence of one or more flavonoid pigments in a small quantity of plant extract and even tentatively identify the individual flavones, provided the R_f values have been previously determined for a pure sample of the pigment in question. The method makes it possible to separate mixed crystals of two or more flavonoids and to identify microquantities of an isolated pigment by running mixtures of the unknown pigment with samples of known composition on the same strip.

While the present study was in progress, E. C. Bate-Smith (*1*) reported the successful separation of anthocyanin pigments by paper partition chromatography and suggested the possibility of separating flavonoid pigments from plant extracts by similar methods. Further work with plant extracts is now in progress in this laboratory and will be the subject of a more detailed report in the near future.

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The Inhibitory Role of "Motor" Nerves

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It is well known that immersion of a nerve-muscle preparation in Ringer's solution, deficient in calcium, results in spontaneous activity which is evident in both the nerve and the muscle. The critical concentration of calcium for frogs' sciatic-biceps femoris preparations is approximately 1 millimolar, at which concentration the nerve commences to ''fire'' spontaneously. When the Ca^{++} concentration is further lowered, the muscle will show spontaneous fibrillation which persists *after* failure of indirect excitation.

We have shown that the failure of indirect excitation of such preparations is caused by a partial (or possibly complete) depolarization of nerve, as evidenced by a decrease in motor-axon resting potential. Restoration of calcium promptly restores the resting potential of the axon and indirect excitability of the muscle, at the same time arresting muscle fibrillation. When a comparison is made of the effects of degeneration of motor nerve following section with those produced by gradual withdrawal of calcium ions from the intact nerve-muscle preparation, the course of events is strikingly parallel. Shortly after nerve section the response of the muscle to indirect stimulation through the distal portion of the nerve is somewhat enhanced, as is the response of the muscle to intra-arterial injections of acetylcholine.

Both of these phenomena are observed in the nerve-muscle preparation when the calcium ion concentration is slightly lowered. As the distal portion of the cut nerve degenerates, indirect excitability of the muscle is lost, and the muscle shows greatly increased sensitivity to intra-arterial injection of acetylcholine. Again, both of these phenomena can be demonstrated in the nerve-muscle preparation when the calcium is lowered to the point where loss of polarization of the nerve is reached, accompanied by failure of indirect excitability. Many of the local anesthetics have been shown to prevent depolarization of axon membranes (*1, 2*); therefore it was not surprising to find that a 1-millimolar solution of procainehydrochloride arrests fibrillation in an intact nerve-muscle preparation immersed in a calcium-free Ringer's solution. We have also shown that procaine, when added to calcium-free Ringer's solution, restores the resting potential of the immersed nerve. The cessation of muscle fibrillation accompanies this restoration and is not due to an effect of the procaine on the muscle itself because the intra-arterial injection of procaine (in concentrations sufficient to block indirect excitability in a *normal* muscle) into a *denervated* fibrillating muscle, failed to disturb its activity. It was also demonstrated that the intra-arterial injection of calcium-free solutions into denervated fibrillating muscles did not modify their activity. These findings indicate the validity of the hypothesis previously advanced by one of us concerning the inhibitory action of the normal polarized resting nerve upon muscle (*3*) and lend support to the belief that the polarized state of the terminal membrane of the normal motor axon, at rest, is inhibitory to the muscle.

Depolarization of the axon membrane or loss of the membrane following section and degeneration of the nerve results in spontaneous muscle activity. Thus passage of a ''motor'' impulse over a nerve does not, strictly speaking, stimulate a muscle to contract, but, as a result of the removal of the inhibiting effect exerted by the polarized end plate of the motor nerve axon, the muscle ''automatically'' contracts. Full details of these experiments will be published shortly.

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Comments and Communications

Cultural and Scientific Conference for World Peace

A few days ago an attractive folder arrived in my mail, outlining, complete with olive branch, a "Call to the Scientific and Cultural Conference for World Peace," scheduled for March 25, 26 and 27 in New York City. The call was made by Harlow Shapley, chairman, and the names of a few prominent scientists appeared among the long list of sponsors.

The "Call" decries our cold war policy, the threats to our intellectual cultural and scientific progress, the curtailment of academic freedom and censorship "on our writers, on the motion picture industry, the theatre and the radio," our enormous military expenditures, and the possibility of World War III, and states that we must "reestablish American-Soviet understanding and cooperation, which alone can make peace possible."

Now certainly no thinking American is in favor of armament and war and all the undesirable economic and political sacrifice that another war would entail. But it is also clear that the only logical and scientific way to solve the problem of establishing and maintaining world peace is to consider not the undesirable symptoms of discord but the underlying cause. We must make every effort at our disposal to prevent the catastrophe of another war and this must be based on some means of getting along with Russia. However, it seems quite clear that peace cannot exist between men or between nations without law and order and that our concept of law and order cannot exist without the authority of a government based on the will of the people.

On the basis of these concepts it seems quite clear that, in view of the present state of international anarchy, our only alternative to defending ourselves by force against a potential enemy with the avowed and acknowledged intent of adopting any measure to overthrow our government and our way of life is to throw every resource into an attempt to establish a federal world government powerful enough to prevent war and protect freedom and justice. In this way we would have a reasonable chance of settling our basic differences with Russia politically and legally, rather than by military action.

It therefore seems to me that to consider the type of recommendations proposed for consideration by the "cultural and scientific conference for world peace" *without at the same time* proposing a sound policy which can assure a mechanism for dealing with Russian-American differences, or those of any other nation, without recourse to war and with preservation of individual freedom and justice under some form of federal world government is definitely inimical to the best interests of citizens of the United States.

As American scientists, we might reasonably ask our colleagues who have taken an interest in this forthcoming conference either to fight within it for adoption of sound, specific proposals for action which might promote world peace (other than unilateral disarmament and appeasement of the present ruthless Russian dictatorship) or to expose the underlying motives of the conference in their true light.

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Terminology for Sedimentation Force in Centrifugation

Adequate terminology for expressing sedimentation force in centrifugation is used by many authors. However, some authors frequently use, for various purposes, the expression of revolutions per minute (r.p.m.) without further qualification to indicate sedimentation force in centrifugation. This manner of expressing the sedimentation condition is almost meaningless to the reader unless either the length of the axis of the centrifuge containers is also given or the type of centrifuge is stated so that the axis may be ascertained and the force computed. The reader deserves an adequate expression of the used force, such as force times gravity or sedimentation constant. If such is not provided, the reader at least is entitled to the information necessary for computing the force times gravity when r.p.m. is used. Since several types of centrifuges and ultracentrifuges with varied length of axis are in use, it is important that more attention be given to adequate terminology.

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Scientific Method and Social Problems

In a discussion of "Science and Security" (*Science*, June 25, 1948, p. 659) E. U. Condon states that "there is still a great reluctance . . . to accept and extend" the use of the scientific method "in the fields of sociology, economics, and politics," and he hopes for "the full acceptance and use of the scientific method in the social sciences."

In this there is the implication that the methods of these sciences are not scientific now—a view that has appeared repeatedly in notes and comments on the needs of social research, and one that is not particularly helpful to those needs. R. O. Bender, in a recent communication (*Science*, December 10, 1948, p. 665), points out some of the discouraging aspects, although he apparently does not altogether accept as final the assumed definition of scientific method. The definition on which such comments are based, as shown in Dr. Condon's discussion, is an equating of science with controlled experimentation. This description of science and scientific method is certainly inadequate. Astronomy has done very well without subjecting the behavior of stars and planets to experimental controls. Geology has not used this method to any notable extent. Most of Darwin's contribution to biology did not come from such an experimental basis, either in its conception or verification. A problem need not be inaccessible to science if controlled experiments are impossible.

It may be true, as Dr. Bender says, that "social science studies conducted to date, with minor exceptions, have been observational and statistical rather than experimental" and that "understandings so achieved are only approximations, and in many cases inaccurate approximations at that, due to inherent limitations of the methods employed." But of course all the understandings achieved by the physical and natural sciences are also only approximations, and of varying accuracy. Fortunate are those scientific disciplines that can, for most of their problems, use the method of controlled experiment to test and improve the accuracy of their hypotheses. The history of these sciences, however, does not suggest that this is the only scientific method of verification, or that the social sciences must choose the method of control (which is so greatly limited in a democratic society) or be denied the status of sciences.

It would be more useful if the physical and natural scientists, instead of preaching a particular procedural definition of scientific method and commending this to their social science colleagues, would recognize that the division of science into the accepted disciplines is merely a convenience arising from the varieties of methods and interests most useful in investigating different aspects of experience and expectation. Science is not any particular method or set of techniques. It is a way of reasoning. The standards are intellectual rather than procedural. The method of observation, formalization, and testing must vary with the nature of the problem.

There is no unique kind of difficulty facing the social sciences that is not met, at least to some degree, in the natural sciences. All sciences must, in some phase and field, and to some extent, try to cope with such restrictive troubles as a high degree of indeterminacy, a highly heterogeneous universe for sampling, the impossibility of controlling variables, the difficulty of translating a factor or concept into an operationally definable identification or measurement, the need for including the inaccessible past history of a datum in an observation, the effect of observer on observed, and a host of other puzzles which challenge the scientific ingenuity and skill of the investigator. Most of these loom much larger in the social sciences, which have in general a more difficult task than the natural sciences. The need for studying and developing the nonexperimental approaches of scientific method is great, since the applicability of controlled experimentation is so limited.

The field of social science, being in effect the problem of how and why mankind behaves, embraces many sciences. The present state of relative isolation of the social sciences from the other sciences (and, indeed, from each other) should not be continued. Social science must draw, in part, on the methods and content of other scientific disciplines; philosophy, the humanities, and religion can also contribute. In turn, social science contributes to the development of scientific method and knowledge for all of science.

There is general agreement that our greatest need is an improvement in behavior and in the prediction and control of behavior and that while our accomplishments in material technology are promising, they are also an overwhelming threat if not accompanied by social advance. Translation of religion into practice by the mass of mankind could solve many of our troubles, but this can hardly be a sufficiently rapid rescue in our present emergencies. Man's most urgent problems are in the area of the social sciences. Their solution will not be speeded by trying to remold these sciences into the image of physics, chemistry, or biology. It may be aided by recognizing that the validity of scientific method is not confined to any one procedure, that methods now in use are open to critique and improvement, that methods developed in one field may presently find unsuspected utility in other fields, and that there may be new methods yet undiscovered.

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Colloidal Electrolytes as a Class Inclusive of Polyelectrolytes, Chain Electrolytes, Long Chain Salts, Dyes, and Detergents

Colloidal electrolytes form one of the largest groups of colloids. In aqueous solution they exhibit properties of both colloids and electrolytes. The author suggested in 1912 (J. W. McBain, E. C. V. Cornish, and R. C. Bowden. *Trans. chem. Soc.*, 1912, **101**, 2042) that this was due to the presence of both charged colloidal particles and ordinary ions. Typical examples were soaps and proteins. The former are association colloids whose particles or micelles are formed by association of ions; the latter are high polymers carrying dissociable groups that are exposed to the solvent.

This classification of colloidal electrolytes has long met with international acceptance, and an extensive literature on the subject has grown up, especially since the advent of synthetic detergents. As early as 1934 the Faraday Society organized an international symposium of over 400 pages on colloidal electrolytes, including such materials as cellulose, starch, proteins, gelatin, dyes, silicates, and a number of inorganic materials (*Trans. Faraday Soc.*, 1935, **31**, 1–421).

Recently (*Science*, November 19, 1948, p. 545) the term "polyelectrolytes" was "coined to describe substances of high molecular weight which are simultaneously electrolytes." The new term was to include "the naturally-occurring polyelectrolytes such as proteins and polysaccharides'' and ''synthetic materials.'' It was shown that polyelectrolytes are highly associated in solution. It was further suggested that ''some of the problems of the biochemist will be reduced to special problems in a broader field—that of polyelectrolytes in general.'' However, these colloidal electrolytes, such as bile salts, have already received much attention both from physical chemists and biochemists, and their properties are just as closely related to the other colloidal electrolytes excluded in the quoted definition of ''polyelectrolytes.''

It would seem that the introduction of such a term would merely lead to confusion in this well established field. The term polyelectrolytes is not self-explanatory and might seem to refer to polyvalent electrolytes or to those that give rise to a variety of ions.

In a previous paper the term ''chain electrolytes,'' which seems equally inapt, was coined (D. Edelson and R. M. Fuoss. *J. Amer. chem. Soc.*, 1948, **70**, 2832). Another partial term is that of ''long chain salts'' (P. F. Grieger and C. A. Kraus. *J. Amer. chem. Soc.*, 1948, **70**, 3803), which is also inadequate.

It now seems impossible to draw a sharp distinction between polymerization and association. Aluminum soaps are one instance of a borderline case. During the past year some authors have classified these as association colloids because their particle size or molecular weight depends upon concentration. Several other authors prefer to regard them as ''polymers of high molecular weight formed by weak intermolecular links'' such as hydrogen bonds. Both groups are describing the same facts.

It would seem advisable to retain the thoroughly established name ''colloidal electrolytes'' for all such materials, even if there are subgroups such as organic, inorganic, organic-inorganic, some that are purely products of association, and others that are simple polymers, or associated polymers, etc. A subgroup such as polyelectrolytes might be useful if it were sufficiently sharply and narrowly defined to include only one definite class of materials. The term ''colloidal electrolytes'' clearly includes them all and emphasizes their interrelatedness and common properties.

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Erratum

May I point out a confusing error that occurs in the last line of Table 1 in our recent short paper (H. H. Plough and Madelon R. Grimm, ''Reversal to Penicillin Sensitivity in a Cysteine-requiring Mutant of *Salmonella*,'' *Science*, February 18, 1949, pp. 173–4). This should read: ''S. D. alone − − − − − − −,'' that is, seven minus signs instead of one minus and six plus signs. I had to correct in galley an error of the original manuscript under a similar heading five lines above, and I assume that somehow the last line got shifted too.

H. H. Plough

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Book Reviews

The chemistry of high polymers. C. E. H. Bawn. New York: Interscience, 1948. Pp. + 249. (Illustrated.) $4.50.

This is an excellent book and fills a real need in the field of polymer chemistry. While more advanced treatises on individual topics have appeared during the past few years, no other book has summarized the whole field of polymer chemistry so clearly and succinctly. The book is very readable and understandable but at the same time has neither sacrificed correctness nor oversimplified the problem.

The book is divided into the following seven chapters: Introduction; Nature and Types of Polymer; Condensation Polymerization; Addition Polymerization; Thermodynamics of Solutions of High Polymers; Size and Shape of Macromolecules; The Structure, Stereochemistry and Crystallinity of High Polymers; and Structure and Physical Properties of High Polymers. Each of these chapters is fairly complete and detailed, with the exception of the last, which is a rather brief outline of the physical properties of high polymers. Fairly extensive references to recent literature are included.

This book should be particularly valuable to the graduate student in chemistry who seeks a broad picture of the present status of polymer chemistry without the necessity of wading through four or five lengthy monographs on highly specific subjects. It also deserves a place on the bookshelves of research workers in the field of polymer chemistry.

Turner Alfrey, Jr.

Polytechnic Institute of Brooklyn

Les richesses de la mer: technologie biologique et océanographique. (Encyclopédie Biologique, XXIX.) Noël Boudarel. Paris, France: Paul Lechevalier, 1948. Pp. 548. (Illustrated.) 1.500 fr.

The information collected in this volume should prove immensely helpful to the more curious fishermen along the French coasts and provide a strong stimulus to those with a bent toward natural history. In addition to short chapters on the origins and development of oceanography, the characteristics of ocean water and bottom, and the common terrestrial plants found along the seashore, there are more extended and profusely illustrated accounts on the algae, mollusks, fish, fish nets and traps, and fisheries. Other groups of marine life receive less full treatment, the criterion for inclusion often being their economic value or relationship to the fishing industry. Each kind of organism is treated under its scientific name, with common names furnished as well as distribution and a general verbal description. Interspersed are many comments on the uses to which the animal is put.

The illustrations are apparently all from original drawings. All are line cuts, and the printer has done well by them. Those of fishing scenes and gear are drawn in good perspective, but they may surprise readers used to halftone illustrations. The lack of halftones is noticed so quickly that one might suppose the book to have been written before the days of photography. The text, however, seems up to date. There is a short bibliography and a good index.

LORUS J. and MARGERY J. MILNE

University of New Hampshire

Psychology. William James. (Introduction by Ralph Barton Perry.) Cleveland-New York: World Publ., 1948. Pp. xxi + 478. (Illustrated.) $1.25.

The reviewer does not know which power of ten to use, but certainly hundreds of living scientists date their interest in psychology from the time they first read James' *Briefer course.* Many will be interested to learn that this renowned text has been reprinted in The Living Library series under the general editorship of Carl Van Doren. No one is better qualified than Ralph Barton Perry to write an introduction to the volume. He refrains from giving us James as "the founder of modern psychology" but is certainly on safe grounds in claiming him as "one of the first to extend the methods and spirit of modern science to the human mind." James' well-known special contributions to psychology, his formulation of the maxims of habit, theory of emotions, and the doctrine of "the stream of consciousness," appeared in his *Principles of psychology*, published in 1890, and were incorporated in chapters in his *Briefer course*, published in 1892. But there was more to James than "special contributions." As later developments have revealed, he succeeded in organizing and expanding the psychology of the past so as to influence strongly subsequent psychology at many points. Prof. Perry briefly traces the reasons why James is considered the originator of "functional psychology," a father of Gestalt psychology, why he markedly influenced abnormal psychology, as well as guidance, educational, and religious psychology. Also, Prof. Perry in his introduction explodes the widely accepted tradition that James was first a psychologist, and later a philosopher.

In James' preface to this text he answers some criticisms of the arrangement of the chapters in his *Principles of psychology.* It seems evident from a footnote, which is a part of the original preface, that he gave much thought to the arrangement of the chapter topics; he was not altogether happy in placing the subject of Sensation first. Further he says: "I feel now (when it is too late for the change to be made) that the chapters on the Production of Motion, on Instinct, and on Motion ought, for purposes of teaching, to follow immediately upon that on Habit, and that the chapter on Reasoning ought to come in very early, perhaps immediately after that upon the Self. I advise teachers to adopt this modified order, in spite of the fact that with the change of place of 'Reasoning' there ought properly to go a slight amount of rewriting."

It has often been forgotten that all of James' chapters except one were written for the textbook, not first for magazine publication, which was only an afterthought and resorted to "because the completion of the whole work seemed so distant."

The words "Briefer Course" appear only on the jacket. The original 66 diagrams are all reproduced in the present edition. The print is clear and beautifully legible, the paper is good, the volume is neat and of a convenient size, (lighter weight than the old one), and there is a 10-page index. Pleasure mixed with nostalgia arises from turning these familiar pages.

WALTER R. MILES

Yale University School of Medicine

Organic reactions. (Vol. IV.) Roger Adams. (Ed.-in-Chief.) New York: John Wiley; London: Chapman & Hall, 1948. Pp. viii + 428. (Illustrated.) $6.00.

This is the fourth volume of a series started in 1942 the general purpose of which was clearly set forth in the *Journal of the American Chemical Society*, 1942, **64**, 3062. The following eight subjects are discussed in an authoritative manner by authors who have had experience with the reactions they are describing: The Diels-Alder Reaction With Maleic Anhydride, by Milton C. Kloetzel (59 pp.); The Diels-Alder Reaction: Ethylenic and Acetylenic Dienophiles, by H. L. Holmes (114 pp.); The Preparation of Amines by Reductive Alkylation, by William S. Emerson (82 pp.); The Acyloins, by S. M. McElvain (13 pp.); The Synthesis of Benzoins, by Walter S. Ide and Johannes S. Buck (36 pp.); The Synthesis of Benzoquinones by Oxidation, by James Cason (57 pp.); The Rosemund Reduction of Acid Chlorides to Aldehydes, by Erich Mosettig and Ralph Mozingo (16 pp.); The Wolff-Kishner Reduction, by David Todd (45 pp.).

Organic chemists will enthusiastically welcome this latest addition to the series. Certainly the remarkable reception given to the first three volumes will be accorded this one also; for the chapters have been carefully prepared and edited and the publisher has again assembled them in a very handy form and in the most attractive manner possible. Although there may be some who will quibble over possible inconsistencies in the nomenclature of the many individual compounds listed at the end of the various chapters and also may observe the omission of one or two references here and there, it is the opinion of this reviewer that the same high standards as set for the previous volumes have been maintained and that again all chemists are indebted to the several authors for their thorough covering of the subject and for their clear writing and excellent presentation.

EVERETT S. WALLIS

Princeton University

Scientific Book Register

BALDWIN, RALPH B. *The face of the moon.* Chicago: Univ. Chicago Press, 1949. Pp. xiv + 239. (Illustrated.) $5.00.

BLACKETT, P. M. S. *Fear, war, and the bomb: military and political consequences of atomic energy.* New York: Whittlesey House, 1949. Pp. vii + 244. $3.50.

BROWN, THOMAS B. *Foundations of modern physics.* (2nd ed.) New York: John Wiley; London: Chapman & Hall, 1949. Pp. xvi + 391. (Illustrated.) $5.00.

COMMITTEE ON DIETETICS, MAYO CLINIC. *Diet Manual.* Philadelphia-London: W. B. Saunders, 1949. Pp. xiii + 329. (Illustrated.)

EGE, VILH. *Chauliodus Schn., Bathypelagic genus of fishes: a systematic, phylogenetic and geographical study.* (The Carlsberg Foundation's Oceanographic Expedition Round the World 1928–30 and Previous "Dana" Expeditions, No. 31.) Copenhagen: C. A. Reitzels; London: Oxford Univ. Press, 1948. Pp. 148. (Illustrated.) 32 Danish Kr. 1£ 13/.

FLORKIN, MARCEL. *Biochemical evolution.* New York: Academic Press, 1949. Pp. vi + 157. (Illustrated.) $4.00.

FREAR, DONALD E. H. *A catalogue of insecticides and fungicides: chemical fungicides and plant insecticides. Vol. II.* Waltham, Mass.: Chronica Botanica, 1948. Pp. x + 153. $5.50.

HAUBER, U. A. *Essentials of zoology.* New York: Appleton-Century-Crofts, 1949. Pp. x + 394. (Illustrated.) $4.00.

MAVOR, JAMES WATT. *A brief biology.* New York: Macmillan, 1949. Pp. viii + 427. (Illustrated.) $4.00.

MELENEY, FRANK LAMONT. *Clinical aspects and treatment of surgical infections.* Philadelphia-London: W. B. Saunders, 1949. Pp. xiii + 840. (Illustrated.) $12.00.

POLUNIN, NICHOLAS. (Ed.) *Botany of the Canadian Eastern Arctic: Thallophyta and Bryophyta.* (Part II). (National Museum of Canada, Bull. 97.) Ottawa: Dept. Mines and Resources, 1947. Pp. iv + 573. (Illustrated.) $1.00.

ROMANOFF, ALEXIS L., and ROMANOFF, ANASTASIA J. *The avian egg.* New York: John Wiley; London: Chapman & Hall, 1949. Pp. xiii + 918. (Illustrated.) $14.00.

Association Affairs

Southwestern Division, AAAS. Frank E. E. Germann, executive secretary-treasurer, has written members of the Division that plans for the Alpine meeting on May 1–5 are already far advanced. Sul Ross State Teachers College, Alpine, Texas and the McDonald Observatory will be joint hosts at the meeting and twelve local committees have been appointed to look after everything from trips to Old Mexico to a free barbeque, which will replace the annual banquet. Members are asked to bring camping clothes instead of formal dress. Abstracts of papers to be preesnted should be in the hands of section secretaries before *April 1.*

The 1949 officers of the Division are R. A. Studhalter, Texas Technological College, president; Ernst Antevs, Globe, Arizona, vice president; and Frank E. E. Germann, University of Colorado, secretary-treasurer. Elected members of the Executive Committee include W. M. Craig (1949), Lubbock; Edna L. Johnson (1950), Boulder; H. P. Mera (1950), Santa Fe; F. H. Douglas (1951), Denver; and O. B. Muench (1951), Las Vegas. Section chairmen and secretaries are, respectively: *Biological Sciences*—Fred W. Emerson, New Mexico Highlands University, and L. C. Hinckley, Sul Ross State Teachers College; *Mathematical Sciences*—Earl Walden, New Mexico College of Agriculture and Mechanic Arts, and B. D. Roberts, New Mexico Highlands University; *Physical Sciences*—A. R. Ronzio, Colorado State College, and J. A. Hancock, Texas College of Mines; *Social Sciences*—E. K. Reed, National Park Service, Santa Fe, and Edward Ferdon, Museum of New Mexico, Santa Fe.

NEWS and Notes

National Science Foundation. The six National Science Foundation bills before the Public Health, Science, and Commerce Subcommittee of the House Interstate and Foreign Commerce Committee will receive early attention, according to a statement made March 10 by Congressman J. Percy Priest, subcommittee chairman. The order of the bills' hearing, he said, was to be decided in an executive session of the subcommittee on March 16.

Congressman Priest plans to urge that the Foundation bills be placed high on the priority list as legislation which already has had considerable discussion and can be quickly disposed of. He expects that brief hearings will be held in order to acquaint new committee members with the issues involved. He urged that all interested individuals and organizations make their views known to the committee at or before the hearings. He mentioned that the only opposition to pending bills he knew of was coming from small manufacturers, particularly in the West, who apparently have been informed that patent policies will be altered to the detriment of the small businessman and inventor. The source of this story seems to have been ''Invention News and Views,'' released by the National Patent Counsel. In November 1948, it carried a news item and an editorial attacking the proposed Foundation legislation as containing ''provisions that would supply almost unlimited development of a bureaucracy authorized to meddle into the most intimate and critical social relations of the citizens as well as to threaten seriously to disturb the orderly development of our interests.'' It is interesting that manufacturers, rather than scientists, should be advising Congressmen on legislation of this type.

The members of the Public Health, Science and Commerce Subcommittee who have the responsibility for this legislation are: *Democrats*—J. Percy Priest, Tennessee, chairman; George C. Sadowski, Michigan; Thomas B. Stanley, Virginia; William T. Granahan, Pennsylvania; A. J. Biemiller, Wisconsin; and George H. Wilson, Oklahoma; *Republicans*—J. P. O'Hara, Minnesota; Wilson D. Gillette, Pennsylvania; Hugh D. Scott, Jr., Pennsylvania; and John B. Bennett, Michigan.

In the Senate, there has been no new action since S.247 was reported out by the Labor and Public Welfare Committee last week (Senate Report No. 90). On March 10 the bill had not yet been placed on the calendar. The filibuster and its after effects may seriously delay final Senate action.

HOWARD A. MEYERHOFF

About People

Britton Chance, former associate professor of biophysics at the University of Pennsylvania School of Medicine, has been appointed director of the Eldridge Reeves Johnson Foundation for Medical Physics at the University's Medical School. Dr. Chance will replace **Detlev W. Bronk,** who became president of Johns Hopkins University last January.

William B. Allington has been appointed chairman of the Department of Plant Pathology at the University of Nebraska. He succeeds **Robert W. Goss,** who will remain as plant pathologist and professor of Plant Pathology, and dean of the Graduate College.

J. C. Hackleman, Illinois College of Agriculture agronomist, was recently honored at a banquet attended by 200 Illinois seed growers who presented him with a cash award in appreciation of his 30 years' work with them. He plans to make a six-month tour of 20 states to study seed improvement work.

R. Ruggles Gates has been appointed an honorary president of the Seventh International Botanical Congress, to be held in Sweden in 1950. Dr. Ruggles is emeritus professor of botany at the University of London, and research fellow in biology at Harvard University.

William Stephenson, director of the Institute of Experimental Psychology, Oxford University, was among the 49 new members recently inducted into the University of Chicago chapter of Sigma Xi. Others were **George Buchi,** Baden Switzerland; **Andrew Fono,** Stockholm; **Rayson Lisung Huang,** Kowloon, Hong Kong; **Augusto Segre,** Rome; **Cesare Emiliani,** Bologna, Italy; and **George T. E. Graham,** Rosetown, Saskatchewan.

Donald W. Pritchard, formerly of the Oceanographic Section of the U. S. Navy Electronics Laboratory, has been appointed director of the Chesapeake Bay Institute, a division of Johns Hopkins University.

Frances Drouet, curator of cryptogamic botany, Chicago Natural History Museum, has returned to his post after three and a half months of botanical exploration on the northeastern coast of the Gulf of Mexico. Dr. Drouet collected about 13,000 specimens of seaweeds, algae, and other plants which will be used for research purposes in the Museum's cryptogamic herbarium.

Alexander Petrunkevitch, professor emeritus of zoology, Yale University, will leave the U. S. March 24, to visit the museums of Great Britain and Continental Europe. His objective is the study and redescription of fossil types of Arachnida. The work, which will take several months, is sponsored by the American Philosophical Society and the Geological Society of America.

John R. Pellam, formerly with the Research Laboratory of Electronics at MIT, has been appointed to the staff of the National Bureau of Standards, where he will conduct research in the Cryogenics Laboratory. Other NBS appointments are: **William Piper,** former project engineer in the Office of Chief Signal Officer, Department of the Army, to the Ordnance Mechanics Laboratory of the Electronics Division; **John W. Utecht,** former chief engineer for the National Scientific Products Company, to the Ordnance Engineering Laboratory, and **Arthur E. Newlon,** formerly of the Stromberg-Carlson Company, to the Ordnance Research Laboratory of the Electronics Division.

James Gordon Cumming, Lt. Col. Medical Corps Reserve, U. S. Army, has retired as director of the Bureau of Preventable Disease, Washington, D. C. Health Department, after 24 years' service with the District government.

F. N. D. Kurie, former associate professor of physics, Washington University, St. Louis, will head the new Nucleonics Division of the Naval Research Laboratory, Washington, D. C. Other members of the Division include **M. H. Johnson, E. H. Krause, E. J. Schremp,** and **M. M. Shapiro.**

On May 1, **Sir Ben Lockspeiser** will succeed **Sir Edward Appleton** as secretary to the Committee of the Privy Council for Scientific and Industrial Research of Great Britain. Sir Ben is now chief scientist at the Ministry of Supply.

D. T. MacDougal, director and founder of the Desert Research Laboratory in Tucson, Arizona, branch of the Carnegie Institute of Washington, has been honored by the California Botanical Society, which dedicated to him an issue of its magazine, *Madroño.*

Robert A. Stauffer has been elected vice president and director of research of the National Research Corporation, Cambridge, Massachusetts. Mr. Stauffer has been associated with the company since 1942.

Visitors to U. S.

Olaug Somme, microbiologist at the University of Oslo, has been a visiting scientist in the Microbiology Division, Scripps Institution of Oceanography, University of California, La Jolla since last August and will visit biological stations on the East Coast before her return to Oslo.

Borg C. Christensen, of the Finsen Memorial Hospital of Copenhagen, Denmark, was a recent visitor at Argonne National Laboratory.

Grants and Awards

The American Petroleum Institute has granted $19,500 to the Microbiology Division, Scripps Institution of Oceanography, University of California, in La Jolla, for continuation of research involving the role of microorganisms in the formation and transformation of petroleum. The present staff includes Claude E. Zobell, director, Frederick D. Sisler, Joseph Q. Heplar, Carl H. Oppenheimer, and Margaret Knight.

Iowa State College has received a grant of $18,000 from the **Rockefeller Foundation** for research in genetics under the direction of J. W. Gowen, head of the genetics department. This is the fourth grant that the College has received from the Foundation for work in genetics.

The 1948 recipients of the $1,000 **Borden Awards** administered by professional and scientific associations have been announced as follows: American Academy of Pediatrics: Dorothy H. Andersen, assistant professor in pathology, Columbia University, and assistant pathologist and attending pediatrician, Babies Hospital and Vanderbilt Clinic; American Institute of Nutrition: Charles A. Carey, chief of Division of Nutrition and Physiology, Bureau of Dairy Industry, U. S. Department of Agriculture; American Dairy Science Association: Walter L. Gaines, professor of Milk Production, University of Illinois; American Chemical Society: Barbour L. Herrington, professor of Dairy Chemistry, Cornell University, and chemist, New York Agricultural Experiment Station; Poultry Science Association: William R. Hinshaw, professor of veterinary science, University of California, veterinarian, California Agricultural Experiment Station; American Dairy Science Association: Egerton G. Hood, chief, Dairy Research, Division of Bacteriology and Dairy Research, Science Service, Dominion Department of Agriculture, Canada.

The Washington Academy of Sciences presented Certificates of Award to three scientists on March 17: to Robert J. Huebner, National Institutes of Health, in recognition of his contributions to knowledge of the transmission of certain rickettsial diseases; to Maxwell K. Goldstein, Naval Research Laboratory, for his distinguished research and development in the field of electronic engineering; and to James A. Van Allen, Applied Physics Laboratory, Johns Hopkins University, for distinguished service in nuclear physics and cosmic rays. Certificates of Merit for demonstrated talent were presented to seven local high school seniors.

The John and Mary R. Markle Foundation has selected its second group of **Scholars in Medical Science** from candidates nominated by accredited medical schools in the U. S. and Canada (see *Science,* August 20, 1948). The program, begun in 1948, is designed to aid young men and women planning careers in academic medicine. Appropriation of $325,000 for their support will be allotted in grants of $25,000 each at a rate of $5,000 a year to the medical schools in which they now hold faculty appointments. The 13 Scholars and the medical colleges nominating them are: Francis P. Chinard, Johns Hopkins University School of Medicine; Don W. Fawcett, Harvard Medical School; Allan V. N. Goodyer, Yale University School of Medicine; John B. Graham, University of North Carolina School of Medicine; John D. Green, Wayne University College of Medicine; George Watson James III, Medical College of Virginia; Ralph Jones, Jr., University of Pennsylvania School of Medicine; George E. Moore, University of Minnesota Medical School; C. Barber Mueller, Washington University School of Medicine; George W. Schwert, Jr., Duke University School of Medicine; Beverly T. Towery, Vanderbilt University School of Medicine; W. Clarke Wescoe, Cornell University Medical College; and Donald R. Wilson, University of Alberta Faculty of Medicine.

Summer Programs

Harvard University will offer a summer program on "Science in General Education at the College Level," to be conducted by James B. Conant, president of the University, assisted by Earl J. McGrath, University of Chicago, Fletcher Watson, of the Harvard Graduate School of Education, and Duane Roller, Wabash College, Crawfordsville, Indiana. Inquiries concerning the course may be addressed to Summer School Office, Wadsworth House, Harvard University, Cambridge 38, Massachusetts.

The Tissue Culture Commission will sponsor a summer course from July 5–30 in the laboratory of the Mary Imogene Bassett Hospital, Cooperstown, New York. The program, dealing with the principles, methods, and applications of tissue culture, will be under the direction of John H. Hanks. Applications should be sent to Mary S. Parshley, College of Physicians and Surgeons, 630 West 168th Street, New York City, before *May 1.*

The School of Library Service of Columbia University will offer a course in medical library literature and administration July 5–August 12. Courses in science literature, advanced information services, biology and physiology are also scheduled. Further information may be obtained from Estelle Brodman, School of Library Service, Columbia University, New York City 27.

Industrial Laboratories

The Western Division of the American Council of Commercial Laboratories will hold its annual meeting March 26, in the offices of Abbot A. Hanks, Inc., San Francisco. Roger W. Truesdail, president of Truesdail Laboratories, Inc., Los Angeles, is chairman of the Western Division, and Herbert D. Imrie, president of Abbot A. Hanks, Inc., is vice president.

A mercury vapor turbine-generator, built by General Electric, has been installed in the Hartford (Connecticut), Electric Light Company's South Meadow Station. Capable of producing 15,000 kilowatts of electricity, the new power plant uses mercury vapor instead of steam to drive the turbine, which in turn drives an electric generator and also supplies extra heat to produce steam for other turbine-generators.

A group of postdoctoral fellowships in the natural sciences, supported by **Merck and Company, Ltd., of Canada,** has been announced by the Research Council of Canada. These fellowships, ranging in value from $2,500 to $5,000, are available to qualified Canadian citizens with a doctorate degree in chemistry or biology for study in selected institutions in Canada and abroad. Information and applications must be received by the Merck Fellowship Board, National Research Council of Canada, Ottawa, before *April 1.*

The Perkin-Elmer Corporation, Glenbrook, Connecticut, announces the development of a new infrared analyzer for continuous automatic analysis of as many as six different components in a flowing stream of sample. The stream may be either in the liquid or gas phase. Cycling time for a six-component analysis is about six minutes. The instrument provides a permanent and accurate record of product concentration and purity, as well as an immediate indication warning of process troubles.

A new $2,500 graduate fellowship in analytical chemistry, supported by **Merck and Company, Rahway, New Jersey,** has been announced by the American Chemical Company. The fellowship is offered for 1949–50, with possible renewal for two years following. Applications must be received not later than *May 1* by the American Chemical Society Fellowship Committee, 1155 16th Street, N.W., Washington 6, D. C.

A color computer which can distinguish 100,000,000 colors—ten times as many as the human eye can see—has been developed by H. R. Davidson, research physicist of General Aniline and Film Corporation of New York City, and engineered by D. W. Imm, of Librascope, Inc., Burbank, California. The computer, called the **Tri-stimulus Integrator,** was designed for use with the General Electric Spectrophotometer, invented by Arthur C. Hardy, of the Massachusetts Institute of Technology. Together, the two instruments analyze colors mathematically so that if one color does not match another the difference can be defined unambiguously.

Meetings and Elections

Methods to prevent conflicting dates of world meetings on medical science and pure and applied biology will be discussed at a council in Brussels, April 4–9. Fifty-four international associations, leagues, committees, and congresses are joining in the council. J. Maisin, general secretary of the International Union Against Cancer, will be chairman of the new coordination committee, and arrangements for the meeting are being made by I. M. Zhukova, head of the Medical Sciences Division of Unesco in Paris.

Kirtley F. Mather, professor of geology, Harvard University, will deliver the **1949 Westbrook Lecture Course,** April 14, 21, and 28 at 8:00 p.m. at the Wagner Free Institute of Science, Montgomery Avenue and 17th Street, Philadelphia. His subject will be "Earth's Resources and Man's Needs." The public is invited.

The American Pharmaceutical Association will hold its annual convention April 24–30 in Jacksonville, Florida. Six affiliated organizations meeting in Jacksonville the same week are: The American Association of Colleges of Pharmacy, National Association of Boards of Pharmacy, the Conference of the Pharmaceutical Association Secretaries, the American Society of Hospital Pharmacists, the American College of Apothecaries, and the American Institute of the History of Pharmacy.

The American Psychopathological Association will hold its annual meeting at the Commodore Hotel in New York City, June 3 and 4. Four sessions will be held, on the clinical, psychological, physiological, sociological, and anthropological aspects of anxiety.

The first annual meeting of the **International Cancer Research Commission,** formed in St. Louis last year (*Science,* November 21, 1947, pp. 479–483), has been tentatively scheduled for July 15–22 in Paris. Further information may be obtained from Ignacio Millan, Chairman, Avenida Veracruz 69, Mexico, D. F. The Commission, which originally consisted of one representative from each of 40 nations, has since been joined by Finland, Iceland, Israel, and New Zealand. Negotiations are under way for Dr. Kinoshita to be appointed as an observer for Japan.

Transactions of the Fourth International Cancer Research Congress (September 2–7, 1947), are being published in five parts, according to an announcement by E. V. Cowdry, president of the Congress. The first part, consisting of 267 pages, including illustrations, tables, and brief summaries of all papers in English, French, German, Italian, Russian, and Spanish, appeared in 1948 as No. 1, Vol. 6 of *ACTA* (Union Internationale Contre le Cancer). The other four parts of the *Transactions* will soon be available. Cost of the complete set will be $25 ($5 for each part), and postal money orders for subscriptions should be sent to J. H. Maisin, Editor, 61 Voer des Capucins, Louvain, Belgium. Reprints of the separate papers can also be obtained from him.

The Council of the National Institute of Sciences of India recently elected the following Honorary Fellows: Louis de Broglie, professor of theoretical physics, Poincare Institute, Paris University; Hans von Euler, professor emeritus of chemistry, Stockholm University; Harlow Shapley, director of Harvard Observatory, Harvard University; and Georg Tischler, Botanical Institute, Kiel University.

Deaths

Floyd Carlton Dockeray, 69, professor of psychology at Ohio State University and former professor at Ohio Wesleyan University, died January 15.

Friedrich Schneider, plant breeder associated with Rabbethge and Giesecke, seed breeders of Einbeck, Germany, died January 31 after a short illness.

Felix d'Herelle, 75, Canadian biologist and laboratory chief of the Pasteur Institute from 1914 to 1921, died February 22 in Paris. From 1928 to 1934 Prof. d'Herelle had served as professor of protobiology at Yale University.

James Rowland Angell, 79, president of Yale University for 16 years, died at his home in Hamden, Connecticut on March 4. Starting as assistant professor of psychology at the University of Chicago in 1894, Dr. Angell was acting president by the last year of his quarter-century there. After his retirement as president of Yale in 1937, Dr. Angell had been associated with the National Broadcasting Company as educational director.

Cosmic ray studies by Cornell University physicists are being carried on in a water tunnel drilled through 193 feet of solid rock more than a century ago by Ezra Cornell who, thirty years later, founded Cornell University. The limestone above the tunnel acts as a filter and only mesons—the most powerful of the cosmic ray particles—reach the automatic recording equipment within the tunnel. The experiments are being conducted by Donald E. Hudson, and Giuseppe Cocconi, researchers in the Laboratory of Nuclear Studies, who are using Geiger counters, an ionization chamber, and other equipment to measure the intensity of the mesons.

The current **Progress Report of Brookhaven National Laboratory** (BNL-AS-1), which combines the administrative and scientific progress for the period July 1–December 31, 1948, is now available. Requests for this report should be directed to the Information Group, Information and Publications Division, Brookhaven National Laboratory, Upton, New York.

The National Registry of Rare Chemicals, 35 West 33rd Street, Chicago 16, has submitted the following list of wanted chemicals: 1,3-dihydroxyanthraquinone; hydroxypyruvic acid; n-triacontanol; carboxymethoxylamine hemihydrochloride; glucose monocarbonate; dibromogermane; neomenthol; 3,5-diiodothyronine; chavicine; 9-ketostearic acid; p-menthane; carone; vanillyl amine; d-pantoyltauryl-p-chloroanilide; sylvestrene; thymidine; n-docosanal; sphingomyelin; trichlorogermane; and tungsten oxide tetrafluoride.

"Fishes of the Western North Atlantic" has recently been published by the Sears Foundation for Marine Research at Yale University's Bingham Oceanographic Laboratory. The 576-page study is the first of a series designed to present in one complete account the results of scientific advances of the past 50 years in the field of ichthyology. The volume is devoted to the most primitive forms of fishes: the lancelets, lampreys and hagfishes, and sharks.

Radioisotopes of cobalt, gold, and carbon are among the 50-odd elements heretofore sold by the U. S. Atomic Energy Commission that will now be made available without charge to approved cancer research workers. Up to this time only iodine, phosphorus, and sodium have been provided free. The only cost to qualified applicants will be $10 per shipment—which will cover packaging, monitoring, and bookkeeping—plus the cost of transportation. Allocation of the free isotopes will be made for studies involving animal subjects, research on basic cellular metabolism of cancerous cells, and experimental programs in evalution of radioactive materials in therapy. Distribution is administered by the Isotopes Division, U. S. Atomic Energy Commission, Oak Ridge, Tennessee and interested investigators should address inquiries there.

Friends and pupils of the late professor Sir D'Arcy Thompson have formed a committee to establish a permanent commemoration of him and have inaugurated a **D'Arcy Thompson Commemoration Fund** for the purpose. The committee proposes to have a replica painted of the oil portrait given by Lady D'Arcy Thompson to the Department of Natural History in the United College and to present the replica to University College, Dundee, where Sir D'Arcy was professor for 33 years. It also proposes to have Alfred Forrest's clay model of Sir D'Arcy cast in bronze for presentation to the University of St. Andrews. Any further information with regard to the plan will be supplied by D. R. R. Burt (Secretary to the Committee), Department of Natural History, The University, St. Andrews, Scotland.

A Special Notice to
Any Prospective Exhibitor
in the
Annual Science Exposition
of the
116th Meeting of the AAAS
New York City,
December 26–31, 1949

If you did not receive a letter inviting your participation in this year's annual Exposition, and if you would like to receive the Official Floor Plan and Booth Rental Information on the release date this month, please write at once to: R. L. Taylor, Assistant Administrative Secretary, AAAS, 1515 Massachusetts Avenue, N.W., Washington 5, D. C.

Quantitative Inferences concerning the Genetic Effects of Radiation on Human Beings

Robley D. Evans, *Department of Physics*
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IN 1927 H. J. MULLER showed that the natural rate of appearance of new mutations in the fruit fly could be increased by irradiation with X-rays (*22*). Similarly, mutations have been produced in many other organisms, including plants such as corn, barley, and beans, by acute and by chronic irradiation. These observations have stimulated much speculation with regard to their applicability to mammalian forms and especially to man.

Lorenz and Heston (*20*) found that mice bred from five to six generations while continuously exposed, 24 hours a day, to 1.1 r and 0.11 r of radium gamma radiation[1] showed no damage to chromosomes, as evidenced by normal litter size and apparently normal life span. Deringer *et al.* (*7*) exposed mice chronically 8 or 24 hours a day to 8.8 r or 4.4 r. Total accumulated doses were for females 770 r and 880 r, and for males 1,100 r. No evidence for the production of visible genetic changes was obtained in the immediate offspring of mice thus irradiated. No evidence was found for the production of chromosome translocations in tests of the offspring of male mice exposed to a total dose of 1,100 r at the rate of 8.8 r given for 8 hours a day, nor in the offspring of female mice which received a total dose of 770 r at the rate of 8.8 r given 24 hours a day.

Hertwig (*14, 15*) demonstrated the production of four recessive gene mutations. Of these, two were produced in the offspring of male mice mated immediately after irradiation (irradiation of mature sperm), and resulted in retarded growth. The second two were produced in offspring of male mice mated after recovery from a period of temporary sterility following irradiation (irradiation of spermatogonia, or sperm-forming cells). They produced anemia and oligodactylism.

The acute dose in Hertwig's cases was 1,500 r of X-rays to the testes (*10*), the rest of the body being shielded to prevent death from whole body irradiation. The mutations were discovered by breeding the sons of the irradiated males to their own daughters. If the entire body had been irradiated at the dosage rate used locally in this experiment it would have received more than twice a lethal dose. Snell (*26*) found that about one-third of the progeny of mice whose testes were exposed to acute doses of about 600 r produced litters of reduced size. This condition of hereditary "semisterility" is believed to be caused by chromosome breakage and translocation (a class of *chromosomal* mutations [*10*]), not by *gene* mutation.

The importance of genetic changes in human beings justifies an attempt to extrapolate to man (*5, 8*) the abundant genetic data on the fruit fly, *Drosophila melanogaster*, and on plants. Catcheside especially has made commendable contributions toward quantitative estimations of the possible genetic effects on human beings of irradiation.

In *Drosophila melanogaster* which has only four pairs of chromosomes, genetic studies have led to the conclusion that the number of individual genes in each long chromosome is of the order of 1,000. We may take the set of chromosomes to include some 3,000 positions for genes. In man the total number of genes per gamete is unknown, but since there are 24 chromosomes, with a total length perhaps 10 to 12 times that of the four chromosomes of *Drosophila melanogaster*, the total number of genes in man is very likely greater than 5,000, and probably lies between 10^4 and 10^5. Recent estimates suggest a value of $(3 \pm 1) \times 10^4$ genes per gamete in man (*28*).

SPONTANEOUS GENE MUTATIONS

In all organisms so far studied, there is a spontaneous gene mutation rate which has an average value such that the probability of mutation is of the order of 10^{-5} to 10^{-6} per gene per generation and appears to be independent of the average life span. Also in man the observed spontaneous mutation rate is about 10^{-5} per generation for hemophilia (*13*) and for epiloia (*11*).[2] Thus in long-lived organisms the gene material appears to be somewhat more stable, per unit of time. The range of numerical values is easily explained on quantum mechanical grounds (*25*). Apparently, the chemical activation energy, for an isomeric change in the configuration of the molecule or molecules comprising the gene, is slightly greater for the genes of long-lived animals. Small differences in this activation energy (which is of the order of 1 to 2 electron volts) can account for differences of several millionfold in the mean life of a gene configuration. Thus the observation that the average spontaneous mutation rate is of the order of 10^{-5} per gene per generation, regardless of life span, is experimentally and theoretically acceptable.

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[1] One roentgen (r) of X radiation or of gamma radiation produces ionization in tissues to an average extent of about 1.6 ion-pairs per cubic micron, or 1.6×10^{12} ion-pairs per gram of tissue.

[2] These two diseases happen to be well suited to the calculation of mutation rates, and no reason is known for suspecting that the rates found should be any higher or lower than for genes whose mutation rates are now unknown. It is, of course, possible that these measured mutation rates in man are automatically selected samples of genes which are relatively more mutable than the average of all genes in man. The decision must obviously await the accumulation of quantitative data on other mutations in man. It is interesting to note that a value of about 10^{-4} per gene per generation was found (*23*) in the Italian population of Rochester, New York, for the mutation causing thalassemia, a disease which appears to be found predominantly in persons of Mediterranean derivation.

If there are N genes per gamete, and if the average probability of a spontaneous recessive mutation is $a = 10^{-5}$ per gene per generation, then aN is the mean number of new recessive mutations per gamete per generation. It has been estimated (*5*) that seriously deleterious and lethal mutations constitute perhaps one-quarter or less of the spontaneous mutations, and that minor recessive mutations predominate. In the long run, the extremely unfavorable mutations leading to hereditary abnormalities are almost wiped out by natural selection. The recessive mutations become distributed in the population of succeeding generations, and appear in an individual only if both parents carry the same recessive mutation.

The generation time for man is about 25 years, or 40 generations in 1,000 years. Thus there has been a long accumulation of recessive mutations, and each individual carries far more mutated genes than have arisen through mutation in his own generation. Because of relatively recent social changes such as the industrial revolution, the human population is not in genetic equilibrium (*12*). The persistence (*12, 16*) of any particular recessive mutation in the population will depend on the degree of inbreeding in the population, loss of particularly unfit mutants by natural selection, loss by reverse mutations or second mutations of the same gene, and interbreeding of semi-isolated population groups. Because genetic equilibrium between mutation and selection cannot be assumed for the slightly deleterious mutants, it seems reasonable to assume, somewhat arbitrarily, that at least $m = 50$ times as many recessive mutations have been accumulated in the population as are produced by spontaneous mutation in each generation. Then if aN is the spontaneous mutation rate per generation, and m is the accumulation factor, the average number of recessive mutant genes per germ cell of each member of the population may be written as $n = m \cdot aN$. Assuming, tentatively, that $m = 50$, we have $n = 50 \cdot aN$.

If a particular sperm cell contains n_1 recessive mutations distributed randomly among N genes, then the chance that a particular designated gene carries a recessive modification is n_1/N. Similarly if an ovum carries n_2 recessives, the chance that the same designated gene carries a recessive mutation is n_2/N. The chance of coincidence, in the union of these two gametes, is then $(n_1/N)(n_2/N)$ for the particular designated gene. Because there are N genes altogether in each gamete, the chance of observing a coincidence of any two recessives in any of these N genes is then $(n_1/N)(n_2/N)N = n_1n_2/N$. Then the statistical chance of the occurrence of a hereditary abnormality or anomaly due to the coincidence of two recessive mutations is $C_0 = n_1n_2/N$. If we assume $n_1 = n_2 = maN = (50 \times 10^{-5})N$, and that N is as large as 10^5, then $C_0 = (2.5 \times 10^{-7})N = 0.025$ is the estimated fraction of all births[3] in which some sort of recessive modification may be expected to appear visibly in the progeny.

RADIATION-INDUCED GENE MUTATIONS

The mutations that can be induced by X-rays, gamma-rays, or ultraviolet light in a variety of organisms are not novel types of changes, but are similar to the mutations that occur spontaneously. The number of mutations produced is simply increased by the irradiation. Radiation-induced recessive mutations can be identical with spontaneous mutations in an unirradiated individual. A gene mutation that has occurred spontaneously or that has been produced by radiation (e.g., $a \rightarrow a'$), can return to the original, or "wild type" ($a' \rightarrow a$), spontaneously or as a result of irradiation of the progeny, although the statistical chance of this happening is low.

Although most of the spontaneous and the radiation-induced mutations are undesirable, a few are advantageous. For example, the present high commercial yields of penicillin are due in part to the exclusive use of high yield strains of *Penicillium*, selected from a large number of radiation-induced mutants of the naturally occurring parent mold (*1–3, 6, 17, 24*). Of course, this high yield is beneficial to *us*, but it has not been proved rigorously that it is beneficial to the *Penicillium*.

In *Drosophila melanogaster*, gene mutations in the X-chromosome of mature sperm have (*5*) an average induction rate of about $b_X = 3 \times 10^{-8}$ per gene per roentgen. The mutation induction rate at a particular gene locus varies by as much as a factor of 5 in either direction from this average value. Most of the measurements have been accomplished by the use of genetic techniques especially applicable to the observation of sex-linked lethals, but enough has been done on sex-linked visible recessives to suggest that the results are similar. Presumably about the same average numerical value will also apply to gene mutations in the other chromosomes, although present genetic techniques have led to numerical results only for genes located along the X-chromosome in irradiated sperm.

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[3] It has been estimated that 22 percent of all human conceptions terminate in nonviable offspring (*28*). This includes all causes of death of the foetus, of which an undetermined but presumably small fraction are genetic causes.

There are measurable differences in the mutation induction rate in sperm of *Drosophila melanogaster* which have been irradiated at various stages in the process of spermatogenesis. When immature sperm are irradiated at the early spermatogonial stage, the number of visible sex-linked mutations eventually produced is only about one-half as great as is found following the same irradiation dose given to mature sperm. The effective ratio of the radiation sensitivity of immature to mature sperm is even smaller (ratio of about 1 : 5) for sex-linked lethal mutations. These effects probably arise because many of the altered spermatogonia, or immature sperm, fail to survive through the process of spermatogenesis and hence never become available as mature sperm (*10*).

At radiation rates of 0.6 r/hr and greater, the number of sex-linked mutations induced in mature sperm of *Drosophila melanogaster* appears to be independent of dose rate (*19*), or quantum energy, and to be linear (*27*) with total irradiation dosage from 25 r to at least 1,000 r. The assumption is usually made that this constant mutation induction rate per roentgen will hold even at very low dosage rates. Recently, however, experiments have been completed (*4*) at the very low dosage rate of 2.5 r/day. Mature sperm of the Canton Special strain of *Drosophila melanogaster*, stored in the spermathecae of females of the Muller-5 strain, were irradiated with radium gamma-rays at a rate of 2.5 r/day for 21 days, at the end of which time the sperm had accumulated a total dose of 52.5 r. The progeny resulting from subsequent fertilization by these aged and irradiated sperm showed an unexpectedly small number of mutations, and indeed was not significantly different statistically from that of unirradiated controls. The number of sperm tested was such that the probability is less than one percent that the result is merely a chance deviation from the rule of proportionality between total dosage and the number of induced mutations. The possibility therefore exists that the genetic effects per roentgen may be less at very low dosage rates than the effects previously observed at higher dosage rates, where repair or recovery of the gene material has not been observed. Further experiments at low dosage rates are needed to answer this question, since it has an important bearing on the "point-hit theory" of radiation effects and on the extrapolation of data to the case of men who are occupationally exposed to radiation at very low dosage rates.

In more recent studies (*27*) of the Canton Special strain of *Drosophila melanogaster* it required a dose of about 50 r to mature sperm in order to double the number of new sex-linked visible and lethal mutations. In these observations the spontaneous mutation rate for sex-linked lethals is 0.0010, while the induced rate is 0.00002 per r. Writing N_X for the number of gene loci on the X-chromosome, we have $a_X N_X / b_X N_X = 0.0010/0.00002 = 50$ r to double the spontaneous mutation rate. If N_X is about 1,000, the spontaneous mutation rate would be about $a_X = 10^{-6}$ per gene per generation, and the induced mutation rate would be about $b_X = 2 \times 10^{-8}$ per gene per roentgen, for this strain under the particular cultural conditions of this experiment.

Quantitative observations of the rate of induction of mutations by radiation have been made in a variety of organisms, including *Drosophila*, tobacco mosaic virus, and bacteria. The results are remarkably similar. Because such widely different organisms as *Drosophila*, virus, and bacteria exhibit substantially the same rate of induced mutation per roentgen, it is usually assumed that about the same average numerical value, $b = 3 \times 10^{-8}$ per gene per roentgen, may also hold for induced mutations in mature germ cells in man.

In man, mature sperm have a fertile life span of about seven weeks (*10*) but the relative sensitivity of sperm and eggs at various developmental stages is unknown. We may represent the time average of the relative radiation sensitivity of immature sperm and eggs in man by k, as compared with the relative sensitivity $k = 1$ for mature gametes. For low level radiation continued over a time which is long compared with seven weeks, k may be significantly less than unity for the male, but substantially unity for the female. If these factors could be evaluated numerically for man, then in the equations and computations which are to follow one would replace the radiation sensitivity, b per gene per roentgen, by the smaller quantities $k_1 b$ for males and $k_2 b$ for females. Because of the large uncertainty in the currently available numerical estimates of k, we would hardly be justified in carrying this refinement into the calculations. So in what follows we shall use the maximum values $k_1 = k_2 = 1$, thereby assuming that immature sperm and eggs have as great a radiation sensitivity as mature gametes. We will therefore overestimate the genetic effects of chronic irradiation, insofar as this particular factor is concerned.

RATIO OF INDUCED TO SPONTANEOUS MUTATIONS

It is interesting to note that cosmic radiation and local gamma radiation, totaling about 0.3 mr per day, are entirely inadequate to account for the natural spontaneous gene mutation rate. Even in a long-lived organism such as man, the dosage from natural sources of radiation amounts to only about 0.1 r per year, less than 3 r between birth and the average childbearing age. Such a small amount of radiation would give only about $3b = 9 \times 10^{-8}$ mutations per gene per generation, whereas the few observed spontaneous human rates of $a = 10^{-5}$ per gene per generation are more than 100 times as large.

We see that a total dosage of the order of $aN/kbN = 10^{-5}/3 \times 10^{-8} = 300$ r per generation is required to bring the induced rate up to equality with the natural rate of mutation per generation. Thus an average dosage of about 300 r per individual per generation would be required to double the natural rate of appearance of new gene mutations per generation. If we chose a lower numerical value for the spontaneous mutation rate, say $a = 3 \times 10^{-6}$, the rate-doubling dose a/b would become about 100 r, provided $k = 1$.

A radiation worker whose whole-body dosage, and hence gonadal dosage, is limited to 0.1 r per working day, as is now the practice in the United States, could at most receive 0.5 r in a five-day week, or 25 r a year, or 250 r in a 10-year working period before childbearing. Actually, the daily average radiation dose per worker will fall far below this maximum because on many days an individual's dose will be much less than the maximum permitted value of 0.1 r. For example, the average daily dose at installations like the Hanford Engineer Works and the Oak Ridge National Laboratory is about 0.005 r. Only rarely does any individual receive the maximum 0.1 r dose. Thus the average 10-year dose, at 0.005 r per day, is only about 20 r for these groups.

In the notation introduced earlier, we may write that the number n_1 of recessive mutants transmitted in an individual's germ cells will be the sum of the accumulated naturally occurring mutants, maN, plus the induced mutants, $kbDN$, where D is the dose in roentgens which this individual receives before he has children. Thus:

$$n_1 = maN + kbDN$$

Writing $n_0 = maN$ for the naturally occurring mutants, and f_1 for the ratio of the new total n_1 to the unirradiated total n_0, we have:

$$f_1 = n_1/n_0 = (maN + kbDN)/maN = 1 + \frac{kbD}{ma}$$

If the numerical values developed earlier turn out to be approximately correct for man, then with $b = 3 \times 10^{-8}$ per gene per r, $a = 10^{-5}$ per gene per generation, an accumulation factor of $m = 50$, and the relative radiation sensitivity of immature to mature gametes $k = 1$, we have:

$$f_1 = 1 + (6 \times 10^{-5})D$$

Thus a radiation worker who received $D = 250$ r before having children will have $f_1 = 1 + 0.015$, and $n_1 = 1.015n_0$, or 1.5 percent more mutants than if unirradiated. If he then has children by an unrelated and unirradiated spouse $(n_2 = n_0)$, the statistical chance of an inherited anomaly due to recessive gene mutations is: $C = n_1 n_2/N = (1.015n_0)n_0/N = 1.015C_0$, or only 1.5 percent greater than the normal chance C_0.

The occurrence of inherited anomalies in the first generation offspring due to *dominant* mutations induced in one parent by radiation is more difficult to estimate numerically because of the lack of numerical data, but may be the more important hazard. Here the accumulation factor, m', will be smaller and will depend more strongly on the degree of unfitness conferred by the particular mutant. The degree of dominance (or "penetrance") of the mutant will affect its visibility as well as its accumulation. For the sake of estimating an order of magnitude, we might make some rough assumptions. If the ratio of induced to spontaneous dominant mutations, (b'/a') is the same as (b/a) for recessive mutations, and if the penetrance is taken at its maximum value of unity, and the fitness taken such that the accumulation is about $m' = 3$, then the ratio, f' of induced to spontaneous dominant mutant genes per gamete would be very approximately:

$$\begin{aligned} f' &= (m'a'N + kb'DN)/m'a'N \\ &= 1 + kb'D/m'a' \sim 1 + k(b/a)D/m' \\ & 1 + 1 \times (3 \times 10^{-8}/10^{-5})D/3 \sim 1 + 10^{-3}D, \end{aligned}$$

or about 1.25 for $D = 250$ r. That is, if the penetrance is unity, then the statistical chance of the appearance of a dominant anomaly in the first generation offspring would be increased by about 25 percent over the chance of the same anomaly's occurring spontaneously. It is interesting to note that the medical literature already contains reports of over 2,250 cases of women whose ovaries were treated with X-rays (mostly 50 to 100 r, for various gynecological conditions) and that no anomalies definitely attributable to radiation have been observed in their subsequent offspring (*9, 10, 18, 21*). The offspring would show dominants, if present, and male offspring would show sex-linked recessives, if present. However, other recessives would not be visible in the first generation offspring.

The natural rate of congenital anomalies C_0 is small, and is already influenced by such factors as nutrition, consanguineous marriages, and socio-economic shifts. Therefore, many eugenists and geneticists feel that no significant eugenic harm would be done by the additional factor of radiation, provided that radiation doses to the general population were confined to values that would not more than double C_0 within the foreseeable future. Whereas we see that the effects in the first generation progeny are small, we must also consider the accumulated effects of recessive mutations over, say, 2,000 years. Because the induced mutations are similar to the natural mutations, and because genetic equilibrium cannot be assumed, we should use the same accumulation factor, m, for the ratio of the accumulated induced mutations present after many generations to the new induced mutations per generation. Dealing now with population averages, and assuming equal average irradiation for both sexes, we have after many generations:

$$\begin{aligned} n_1 = n_2 &= maN + mkbD_1N \\ &= n_0(1 + kbD_1/a) \end{aligned}$$

where D_1 is the average, over all individuals of both sexes, of the number of roentgens to the gonads per generation up to the end of the childbearing period. If we require that the congenital anomalies be no more than doubled, then

$$2 = \frac{C}{C_0} = \frac{\dfrac{n_1 n_2}{N}}{\dfrac{n_0 n_0}{N}} = \left(1 + \frac{kbD_1}{a}\right)^2$$

hence: $$1 + kbD_1/a = \sqrt{2}.$$

It is to be noted that this general result, for the condition after many generations, is independent of the accumulation factor m, and that the genetically permissible average dose D_1 depends only on the average spontaneous mutation rate a, and the average induced mutation rate b. Again assuming $a = 10^{-5}$ per gene per generation, $k = 1$, and $b = 3 \times 10^{-8}$ per gene per roentgen, we find:

$$\begin{aligned} D_1 &= (\sqrt{2} - 1)(a/kb) \\ &= 0.414 \times 10^{-5}/3 \times 10^{-8} \\ &= 140 \text{ roentgens.} \end{aligned}$$

Since the dose D_1 deals with population averages (both men and women) and is the mean dose per head, $D_1 = 140$ r could be realized by 100 percent of the population receiving 140 r, or 50 percent receiving 280 r, or 10 percent receiving 1400 r, etc. If, for example, as many as five percent of the total population received an average dose of 280 r before childbearing, then the average dose to the entire population would be $0.05 \times 280 = 14$ r, and the eventual fractional increase (after, say, 2,000 years) in congenital anomalies due to radiation could be expected to be about:

$$\begin{aligned} C/C_0 &= (1 + 3 \times 10^{-8} \times 14/10^{-5})^2 \\ &= (1 + 0.041)^2 \\ &= 1.08 \end{aligned}$$

or only eight percent greater than the spontaneous rate in a similar unirradiated population. If we assume a smaller value for the spontaneous mutation rate, say, $a = 3 \times 10^{-6}$, then for $C/C_0 = 2$, the average dose per head per generation becomes $D_1 = 42$ r, while an average dose of $D_1 = 14$ r would give only $C/C_0 = (1 + 0.14)^2 = 1.30$, or 30 percent greater than the spontaneous rate in a similar unirradiated population.

Conventional equilibrium theory. In a statistically large population, it is well known (e.g., Hogben, *16*, p. 195) that if s is the fractional reduction of net fertility in individuals who are homozygous with respect to a particular recessive mutant, then when genetic equilibrium between selection pressure and mutation pressure is reached, the gene frequency of this recessive will be $\sqrt{a/s}$. Thus in our notation, $ma = \sqrt{a/s}$, or $m = \sqrt{1/as}$ for spontaneous mutations, while $ma + mbkD = \sqrt{a + bkD)/s}$ for the sum of the spontaneous and the induced mutations. However, if the selection coefficient, s, is small, as is probable for many of the minor recessive mutations, then constant conditions over a period of many thousand generations are required before genetic equilibrium with respect to such genes is closely approached (e.g., Hogben, *16*, p. 143). Even so, this standard treatment in the existing mathematical theory of genetics neglects reverse mutations or second mutations of the same gene, inbreeding, statistical fluctuations in partially isolated population groups of finite size (*29*), and population shifts which result in interbreeding between population groups.

It may be worth while to note what could be deduced for human populations, if it were permissible to assume genetic equilibrium. The effective accumulation factor $m = 1/\sqrt{as}$ for minor recessive mutations might then be of the order of magnitude of 1,000 or more after many thousand generations of constant conditions. This would reduce our estimate of the first generation effects by a factor of $1{,}000/50 = 20$ or more, and suggests that our estimate of $m = 50$ for the nonequilibrium case may even be unduly conservative. After thousands of generations of exposure to D_1r per generation, the new equilibrium mutant gene frequency per gene locus would be $\sqrt{(a + kbD_1/s}$, and the ratio C/C_0 of birth anomalies in irradiated and unirradiated populations would become $(a + kbD_1)/a = (1 + kbD_1/a)$, instead of the square of this quantity, as derived for the nonequilibrium case. Thus again, the numerical estimates made on the nonequilibrium, or square-law model, appear to lie well on the conservative side.

Many simplifications of known genetic facts have had to be made in arriving at these numerical values but the analytical form and the general order of magnitude of the results should not have been altered thereby. Certainly the gradual accretion of knowledge in cytogenetics will permit future refinements in such calculations. Although one cannot be dogmatic where extrapolations of data are involved, it does seem highly improbable that any detectable increase in hereditary abnormalities will result, even after many generations, from daily radiation doses up to 0.1 r per day given to a small fraction of the population.

To review the genetic concepts and experiments most pertinent to the question of mutations induced by radiation: For a variety of organisms, the probability of a spontaneous gene mutation is of the order of 10^{-5} to 10^{-6} per gene per generation, and is substantially independent of the life span. Experiments on several types of organisms have shown that irradiation can produce gene mutations. These induced mutations are not novel types, but appear to be entirely similar to those which occur spontaneously. When the irradiation is carried out at a rate of 0.6 roentgens per hour, or higher, the average probability of inducing a gene mutation is about 3×10^{-8} per gene per roentgen. The spontaneous mutation rate is therefore very much higher than could be expected as a result of the cosmic radiation and local gamma radiation (0.3 mr/day) and is therefore due to other causes than irradiation. When the irradiation of experimental organisms is carried out at a low rate (order of 1 to 8 roentgens per day) no induced mutations have yet been observed in the organisms studied (fruit fly, mouse). This suggests that the effective average radiation sensitivity of immature sperm and eggs may be less than the sensitivity of mature sperm and eggs. Dominant mutations may become visible in the first generation offspring. Recessive mutations may appear only in homozygous individuals of a later generation, and therefore recessive mutations accumulate in the population as a result of both spontaneous and induced mutations. From the appropriate mathematical theory, and the experimental data now available, it seems safe enough to conclude that no detectable increase in hereditary abnormalities is likely to result, even after many generations, if a small fraction of the population receives daily radiation doses up to 0.1 roentgen per day.

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Neomycin, a New Antibiotic Active against Streptomycin-Resistant Bacteria, including Tuberculosis Organisms[1]

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THE ISOLATION OF STREPTOMYCIN from two strains of an actinomyces identified as *Streptomyces griseus*, was reported (*8*) from this laboratory five years ago. This was later followed by announcements that this antibiotic is highly effective against the tuberculosis organism (*9*), that it is active *in vivo* against a variety of pathogenic bacteria, and that it is not very toxic to animals (*7*). The ability of streptomycin to control experimental tuberculosis was soon established (*2*). Within less than a year after the isolation of streptomycin had been reported, its effectiveness upon certain forms of human tuberculosis was demonstrated (*3*). Thus, for the first time in the history of human tuberculosis, a drug was found which could be used in the treatment of tuberculosis by means of chemotherapeutic agents and which pointed to the possibility of finally eradicating the "white plague" of man.

Streptomycin has, however, certain important limitations, chief among which are (a) its neurotoxic potentialities, and (b) the development of resistance among the infectious organisms upon its prolonged administration. Recent experiments (*4*) seem to indicate that the toxic reactions can apparently be overcome, at least partly, by the use of dihydrostreptomycin, a reduced form of streptomycin. The problem of development of resistance remains, therefore, as the major limitation of this antibiotic, especially in the treatment of tuberculosis.

The possibility of isolating or synthesizing new compounds that would be effective against the streptomycin-resistant strains of bacteria suggested itself. Various reports indicated that certain synthetic compounds such as the sulfones and para-aminosalicylic acid, and various antibiotics such as different forms of streptothricin (*5*) and aureomycin (*1*) might prove to possess such properties. Although the results obtained thus far in some of the preliminary investigations with these substances are highly encouraging, they still appear to be inconclusive. We do not yet know whether or not any of these would serve to replace streptomycin, completely or partly, or to supplement it on more than a very limited scale. They may not be sufficiently active against the bacteria, or they may be toxic to animals and man, or they may lack stability, or have some other limitations.

In connection with the studies on the production of antibiotic substances by microorganisms, carried out in our own laboratories since 1939, many thousands of cultures, mostly actinomycetes belonging to the genus *Streptomyces*, were isolated from soils, composts, peats, and other natural substrates and tested for their activity against different bacteria; emphasis has been laid, in recent years, upon the mycobacteria. Surprisingly enough, a large number of the organisms thus isolated were found to possess considerable activity against *Mycobacterium tuberculosis*. Unfortunately, only a very few of the antibiotics produced by these organisms proved to be suitable chemotherapeutic agents, because of various limitations, some of which were just mentioned. The fact that numerous strains and species of *Streptomyces* possess the capacity to inhibit the growth of mycobacteria, however, and even to produce active antituberculosis compounds, and the fact that one of these, streptomycin, already had found practical application as a chemotherapeutic agent, offered the hope that sooner or later other substances would be found that might be even better. In search for new compounds, particular attention was paid to those that would be effective against streptomycin-resistant bacteria, notably against the streptomycin-resistant strains of *M. tuberculosis*. The discovery of such an agent, designated as *neomycin*, is reported here.

The organism producing neomycin was isolated from the soil. It is somewhat related to a culture isolated from the soil in 1915 by Waksman and Curtis (*10*) and designated as *Actinomyces fradii* (now listed in Bergey's Manual as *Streptomyces fradiae*).

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[1] Paper of the Journal Series, New Jersey Agricultural Experiment Station, Rutgers University–The State University of New Jersey. Department of Microbiology. This work was supported by a grant from the Rutgers Research and Endowment Foundation.

[2] The authors wish to express their sincere appreciation to Dr. A. Swart, Miss D. Hutchison, Mr. D. Harris, Mr. W. Iverson, and Mr. E. Katz of this laboratory, for assisting with some of the investigations reported here; also to Mr. J. Frankel of this laboratory, and Mr. O. Graessle, of the Merck Institute of Therapeutic Research, for assisting with the *in vivo* studies.

When the newly isolated culture was grown in various media containing a source of nitrogen (peptone, meat extract), a carbohydrate (glucose), and salt (NaCl), it was found to produce neomycin under both stationary and submerged conditions of culture. The antibiotic can easily be removed from the culture medium and concentrated by the methods of adsorption and elution which have been developed for the isolation of streptothricin and streptomycin from their respective culture media.

TABLE 1

ANTIBACTERIAL ACTIVITY OF CULTURE FILTRATE CONTAINING NEOMYCIN

Test organism	Units of activity in 1 ml of broth	
	Incubation* 3 days	Incubation* 5 days
Escherichia coli	60	100
Bacillus subtilis	850	1,000
B. mycoides	880	400
Staphylococcus aureus ..	830	330
Mycobacterium 607	830	1,000
M. ranae	880	1,000
M. avium	200	600
M. phlei	830	1,000

* Shaken cultures incubated at 28° C.

TABLE 2

ANTIBIOTIC SPECTRUM OF CRUDE NEOMYCIN, AS COMPARED TO THAT OF CRUDE STREPTOMYCIN AND STREPTOTHRICIN

Test organism	Dilution units per gm required to inhibit growth of test organisms		
	Neomycin	Streptomycin*	Streptothricin*
B. subtilis	150,000–750,000	125,000	125,000
B. mycoides	20,000–150,000	20,000	1,000
B. cereus	20,000– 60,000	80,000	1,000
S. aureus	100,000–250,000	15,000	50,000
S. lutea	10,000	100,000	37,500
E. coli SS†	25,000	25,000	25,000
E. coli RS‡	20,000	0	Active§
Ps. aeruginosa	2,500	1,000	1,000
Pr. vulgaris	25,000	10,000	12,500
Bodenheimer's organism	15,000	0	Active§
Serratia marcescens	20,000	25,000	1,200
Mycobacterium 607	80,000–250,000	Active§	Active§
Mycobacterium 607RS	50,000–150,000	Inactive	Active§
Trichophyton mentagrophytes	< 300	< 300	Active§
Candida albicans	< 300	< 300	Active§

* From Shatz, Bugie and Waksman (6).
† SS = streptomycin-sensitive.
‡ RS = streptomycin-resistant.
§ Active = activity established in other reports.

Neomycin is a basic compound, most active at an alkaline reaction. It is soluble in water and insoluble in organic solvents. It is thermostable. It is active against numerous Gram-positive and Gram-negative bacteria, especially mycobacteria, but not against fungi. This is brought out in Tables 1 and 2. The antibiotic spectrum of the crude neomycin is quite distinct from that of streptomycin, on the one hand, and of streptothricin, on the other.

TABLE 3

EFFECT OF NEOMYCIN UPON THE GROWTH OF DIFFERENT STRAINS OF *M. tuberculosis* IN DUBOS MEDIUM*

Test organism	Growth inhibition units/ml
M. avium†	4.0
M. avium R†‡	4.0
M. tuberculosis H37Rv†	0.1
M. tuberculosis H37RvR†	0.2
M. tuberculosis H37Rv	0.5–1.0
M. tuberculosis H37RvR	1.0
Mycrobacterium 607	0.1
Mycrobacterium 607R	0.25

* Incubation at 37°/C for 14 days.
† This particular test was made in another laboratory.
‡ R = streptomycin-resistant strain.

Neomycin preparations were found to possess several desirable properties, which fully justified a more detailed study of this antibiotic: (1) similar activity against both streptomycin-sensitive and streptomycin-resistant bacteria; (2) considerable activity (in some cases greater activity than streptomycin) against various forms of *M. tuberculosis* and other mycobacteria (see Table 3); (3) limited toxicity to animals or none; (4) activity against various bacteria *in vivo*, including Gram-positive and Gram-negative organisms and against both streptomycin-sensitive and streptomycin-resistant organisms (see Table 4); (5) lack of resistance against neomycin among the organisms sensitive to it, or only limited development of such resistance.

TABLE 4

COMPARATIVE ACTIVITIES OF NEOMYCIN AND STREPTOMYCIN *in Vivo* UPON STREPTOMYCIN-SENSITIVE AND -RESISTANT BACTERIA

No. of animals or embryos	Treatment	Dilution of bacterial culture	Surviving mice or egg embryos in days			Percent survival
			2	5	10	
	Staphylococcus aureus—streptomycin-sensitive*					
5	Control	10^{-3}	0	0	0	0
5	Control	10^{-5}	1	1	1	20
5	Streptomycin, 25 μg	10^{-3}	5	5	5	100
5	Streptomycin, 100 μg	10^{-3}	5	5	5	100
3	Neomycin, 50 units	10^{-3}	3	3	3	100
3	Neomycin, 200 units	10^{-3}	3	3	3	100
	Salmonella schottmulleri—streptomycin-resistant*					
5	Control	10^{-3}	0	0	0	0
5	Control	10^{-4}	4	2	0	0
5	Streptomycin, 100 μg	10^{-4}	2	0	0	0
5	Streptomycin, 5000 μg	10^{-4}	1	1	1	20
5	Neomycin, 100 units	10^{-3}	5	5	5	100
5	Neomycin, 200 units	10^{-3}	5	5	5	100
	Salmonella pullorum—streptomycin-sensitive					
10†	Control	10^{-3}	4	0	0	0
10	Control	10^{-4}	6	0	0	0
10	Neomycin, 100 units	10^{-3}	5	5	5	50
10	Neomycin, 100 units	10^{-4}	9	9	9	90

* Subcutaneous, single dose; mice used.
† Inoculation into allantoic cavity, single dose.

When a 20-hour-old agar culture of *E. coli* was suspended in water and plated out in nutrient agar containing 5 μ or 25 μ of neomycin per ml, no colonies of *E. coli* developed out of 22 billion cells, after 9 days' incubation at 28° C. Similar concentrations of streptomycin would usually allow the development of a dozen or more bacterial colonies per plate. When pieces of agar were removed from the plates containing neomycin and inoculated into sterile agar plates, only the 5 μ/ml plate gave growth from some of the pieces, but the 10 μ/ml and the 25 μ/ml plates gave no growth at all, thus pointing to the high bactericidal properties of neomycin. When plates containing different concentrations of this antibiotic were streaked with streptomycin-sensitive, -resistant, and -dependent strains of *E. coli* (*9*), the first two were sensitive alike to neomycin, and the last did not make any growth at all. This established further the difference in the biological and chemical nature of neomycin from streptomycin.

Broth or agar cultures containing sufficient neomycin to inhibit the growth of various bacteria were incubated for considerable periods of time. No further bacterial development occurred beyond a certain initial inhibiting concentration, thus pointing on the one hand to the stability of neomycin, as contrasted to that of aureomycin, and on the other hand to the lack of resistance developed among the sensitive bacteria, as contrasted to streptomycin and especially to grisein.

Since neomycin has not yet been obtained in crystalline form, very little can be said of its chemical nature. Preliminary results, however, point to its being distinctly different chemically from streptothricin and from streptomycin. More detailed studies will be published later.

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TECHNICAL PAPERS

Electron Micrographic Observations of Tobacco Mosaic Virus in Crude, Undiluted Plant Juice[1]

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Several reports have been published (*2*, *3*, *4*, *5*, *6*) of electron microscopic studies of the tobacco mosaic virus in various degrees of impurity. In no study, however, has the infected juice been used in its crude, undiluted form. There has always been some degree of treatment, if only with distilled water, prior to observation in the electron microscope. The published micrographs of the impure material are qualitatively similar to those obtained from freshly purified material.

We have recently obtained electron micrographs of a wild strain of tobacco mosaic[2] grown in White Burley tobacco plants. The specimens for the microscopic examination were prepared in this way: A small portion of the tobacco leaf was crushed by a round-end glass rod in a small glass tube. A drop of expressed juice was picked up in a micropipette, and a bubble was blown over the surface of the specimen screen. The bubble was quickly wiped across the screen, and a very thin film of material was left behind. This film dried almost instantly, and the dried specimen was then shadowed with uranium. The total elapsed time between expressing the juice and drying the film was about 15 sec.

FIG. 1. Electron micrograph of expressed, crude juice of White Burley tobacco leaf infected with a wild strain of tobacco mosaic virus. Note the bundle-like forms in which the virus is seen. Magnification is 30,000 ×.

FIG. 2. Electron micrograph of the same infected material as is shown in Fig. 1, except that the dried preparation was washed briefly with distilled water. Note that the virus particles are now partially dispersed in individual rods. Magnification is 30,000 ×.

A typical micrograph from a 14-day-old infection is shown in Fig. 1. As can be readily seen, the virus particles appear in the form of large bundles, or sheaves, whose length is roughly 1 to 3 μ, and whose diameter, or width, varies greatly but might average 150 mμ. The background appears quite coarse, since it consists of all of the nonvolatile plant material. Uninfected plants are found to exhibit none of these bundle-like forms. The size and frequency of the typical forms shown in Fig. 1 increase with the age of the infection, being barely visible at 36 hrs after inoculation.

Fig. 2 illustrates the probable reason why previous work with "crude" juice has not exhibited the sheaves of virus particles. The specimen shown in this micrograph was prepared like that in Fig. 2, up to the shadow-casting, but was then washed with two drops of distilled water and allowed to dry. It was then shadowed with uranium. Even such a light and brief treatment with distilled water is evidently sufficient to bring about extensive disintegration of the bundles and to cause many typical, single particles to become visibly detached from the larger groups.

It is well known from observations with the optical microscope (*1*) that needle-like forms are found to exist *in vivo* in the hair-cells of an infected plant, particularly when the cell has been slightly injured or treated with mild acid. It is entirely possible that what is seen in detail in the electron micrographs is identical with the needle-forms recognized in the optical microscope.

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[1] These results have been orally reported at the recent meeting in Toronto of the Electron Microscope Society of America and at the Autumn Conference on Electron Microscopy in Cambridge, England. The work is part of a program supported by a grant-in-aid from the American Cancer Society, on recommendation of the Committee on Growth of the National Research Council.

[2] The initial virus used for propagation in our laboratory was kindly furnished by Gerald Oster.

The interesting question in connection with these preliminary results is whether the groups of virus particles exist as such in the intact plant cells, or whether they form subsequent to the crushing of the cells. If the latter is true, they can be considered aggregates of the individual virus particles. But if further work should show that they exist in the intact cells, then the interesting question will arise as to whether or not the virus bundles represent the geometrical growth pattern of the virus.

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Infrared Spectra and the Amide Linkage in a Native Globular Protein

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The presence of absorption characteristic of amides in the 6-μ region of the spectrum has been observed in proteins by several investigators (*1, 6, 8*) and has frequently been cited as evidence against the "cyclol 6" structure postulated by Wrinch (*9*) for native protein molecules. The results reported, however, have been for insoluble, fibrous proteins or for samples in the form of a dried film. In view of the pronounced sensitivity of proteins to drying, as well as to deposition in a film, it has always been possible to cast doubt on this evidence for the amide linkage, at least insofar as native globular proteins are concerned, on the ground that the molecule had been denatured during the experiment.

A protein which is relatively stable to the drying process is serum albumin. It has also been observed recently that native serum albumin produces a modification in the visible spectra of many compounds (*5*) and that this ability is lost on denaturation (*5*). It has seemed appropriate, therefore, to examine the infrared absorption of a dried film of crystallized bovine serum albumin and then to test the sample for possible denaturation by seeing whether it is still capable of causing characteristic spectrophotometric shifts.

The infrared absorption spectrum of bovine serum albumin in the 6-μ region is illustrated in Fig. 1, together with the synthetic, water-soluble, polypeptide, polylysine (*8*)[1] for comparison. The C=O peaks at 6.05 and 6.10 μ are essentially identical in position and characteristic of the simple amides in the solid state (*4, 7*). Thus there can be no doubt that amide carbonyl groups are present

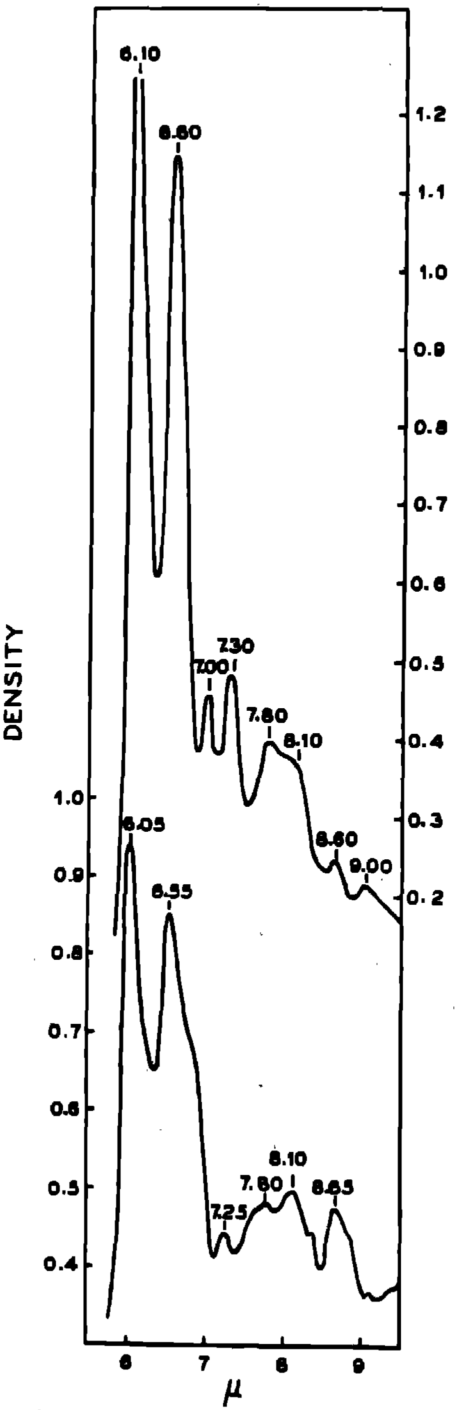

Fig. 1. Infrared absorption spectra of films of bovine serum albumin (top) and polylysine (bottom).

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[1] We are very much indebted to E. Katchalski for his generous gift of a substantial sample of polylysine hydroiodide.

in the film of bovine albumin used to obtain the spectrum illustrated.

That this same sample of bovine serum albumin was still in the native form is demonstrated by the data in Table 1. The protein film, dissolved in phosphate buffer at pH 7.6, depressed the optical absorption of methyl orange, as is characteristic of native albumin. Furthermore, the degree of depression, in comparison with that obtained with the control, untreated sample, was roughly in proportion to the quantity of protein. Clearly then, no significant fraction of the albumin was denatured by deposition as a film, drying, or infrared radiation.

TABLE 1

TEST OF NATIVE CHARACTER OF DRIED PROTEIN FILM BY EXAMINATION OF ITS EFFECT ON SPECTRUM OF METHYL ORANGE

Wave length (A)	Depression of optical density by protein	
	From dried film*	Untreated†
4,600	0.063	0.099
4,700	0.097	0.138
4,800	0.117	0.165
4,900	0.134	0.175
5,000	0.123	0.167

* Contained 8 mg of protein.
† Contained 12 mg of protein.

In view of these experiments, there would seem to be little room left for doubt that native, globular proteins contain an amide-type carbonyl group.

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The Effect of Choline-Deficiency on Uterine Activity of Rats

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Peet and Sampson (*7*) reported recently that two post-partum albino rats, one nursing young and one nonlactating, maintained for 39 days on a choline-deficient diet, were found at autopsy to lack completely contractility of the uterus and to have partial atrophy of the uterus and ovaries. Two controls, both nursing young, which received respectively 30 mg and 200 mg of choline every second day, showed normal uterine activity. A yellow, oily condition of the hair on the rats receiving the choline supplements was also noted.

The work reported here was undertaken on a larger group of animals to confirm these observations if possible.

Nine Carworth Farms adult virgin female rats of the Wistar strain were used unmated and nine similar rats were mated. Two of the mated rats died during pregnancy and seven delivered litters, six of these nursing from 7 to 10 young apiece. All virgin rats were placed on the experimental diets at the same time, and each mother was given the experimental diet following delivery of her litter. The diets were distributed among the animals as follows: 3 virgin females on Purina Dog Chow; 3 virgin females, 3 nursing females, and 1 postpartum nonlactating female on the choline-deficient diet; and 3 virgin females and 3 nursing females on the choline-deficient diet plus a choline supplement.

TABLE 1

EFFECTS OF CHOLINE-DEFICIENCY AND LACTATION ON BODY WEIGHT AND ON OVARIAN AND UTERINE WEIGHTS

Rats & diet	No. in group	Average body weight change	Average ovarian weight	Average uterine weight
Nonlactating virgin rats				
Chow controls	3	+ 38 gm	68 mg	476 mg
Diet controls	3	+ 37 gm	66 mg	445 mg
Choline-deficient ..	3	+ 39 gm	59 mg	421 mg
Nonlactating postpartum rat				
Choline-deficient ..	1*	+ 56 gm	64 mg	438 mg
Nursing rats				
Diet controls	3*	− 29 gm	74 mg	244 mg
Choline-deficient ..	3*	− 40 gm	69 mg	291 mg

* One animal from each group was removed from the yeast-casein supplement during the last 14 days of the experiment.

The choline-deficient diet developed by Hegsted and associates (*6*) was used in this work as it was in the work by Peet and Sampson.

The 30 mg choline supplement given every second day was chosen for all control animals in preference to the 200 mg since that amount more nearly approximates physiological levels of the substance (*1, 2, 4, 8*). The additional supplement (*7*) of 1 gm dried brewer's yeast and 5 gm extracted casein was provided every second day to all rats on the basal diet except 3, which were deprived of it completely for the last 14 days of the experimental period in an effort to intensify the choline-deficiency.

Vaginal smears were taken daily and rats were weighed at weekly intervals. All rats were killed by cerebral concussion on the 39th day with the exception of the animals on the Dog Chow diet, which were killed at later intervals when control uteri were desired. At the time of experimentation the ovaries and uteri were rapidly excised, cleaned of excess fat, and weighed.

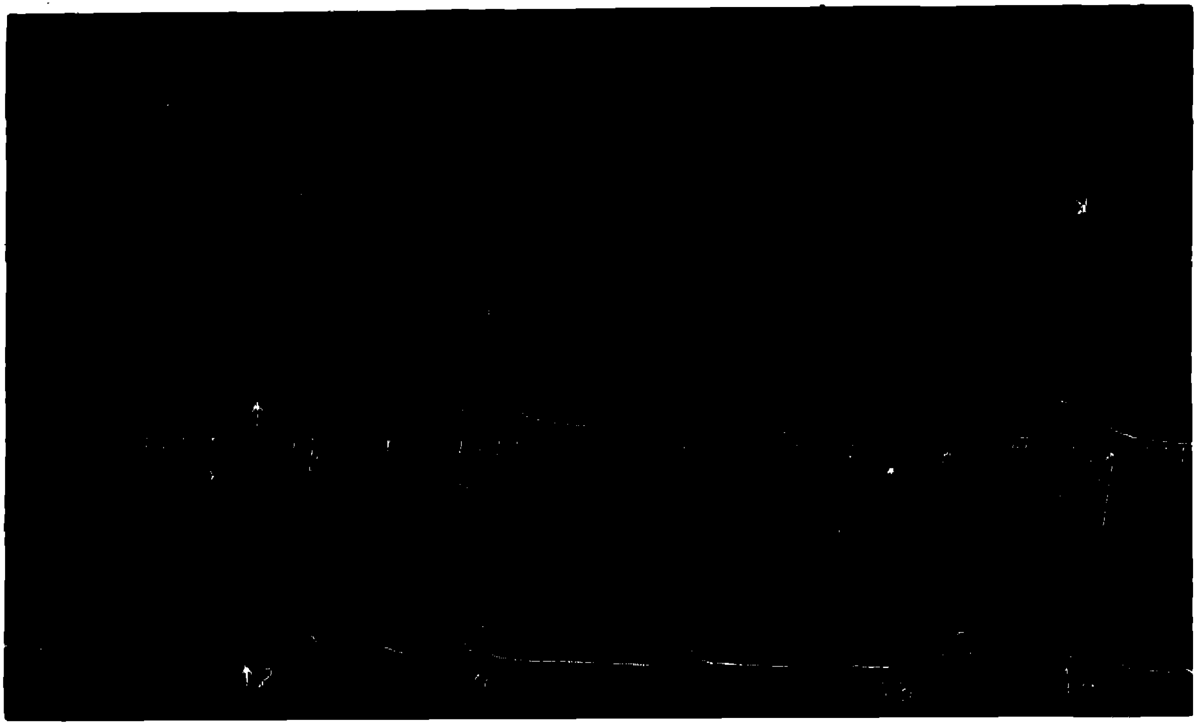

FIG. 1. Top curve shows the spontaneous contractions of the uterus taken from a rat on a choline-deficient diet (animal was deprived of yeast supplement during the last 14 days) and the bottom curve, the activity of a similar segment of uterus taken from a normal rat. Middle record is the time in intervals of 20 seconds. At the interval marked 2, acetylcholine chloride was added to the bath, making a 1 : 25,000,000 solution. At W, the acetylcholine-Locke's solution was replaced by fresh Locke's solution. At 3, posterior pituitary solution (1/250 U.S.P. unit) was added to the 100-cc bath. At 4. epinephrine was added to make a 1 : 2,000,000 dilution.

Segments of one horn of the uterus taken from each of two animals were placed in aerated Locke's solution at 38° C ± 0.2° for recording the contractions on a smoked drum surface. The method used was the same as that previously described by one of us (*5*). Generally, segments of one horn from an experimental animal and of one horn from a control animal were studied simultaneously. All preparations were tested for their response to posterior pituitary solution (1/5th to 1/1,000th unit in 100 cc bath), epinephrine solution (1:2,000,000) and acetylcholine (1: 25,000,000 to 1: 200,000,000).

During the course of the experiment, the fur of all nursing mothers and their litters became oily, apparently about the time the young started to get into the food containers in the cages, while at no time did oiliness of the fur appear in any nonlactating rat.

Table 1 reveals no essential differences in either the nursing or the nonlactating groups between the choline-deficient animals and their controls. There are, however, differences between the nursing animals considered as a group and the nonlactating rats as a group, indicative of an inadequacy of the diet for lactation, despite the addition of choline. Every nursing rat lost weight during the 39-day experimental period while every nonlactating rat gained weight. The uteri of the 6 nursing mothers varied in weight from 168 to 427 gm with an average of 268 gm, while the uteri of 10 nonlactating rats ranged from 318 to 560 gm with an average of 446 gm. The two nursing rats, one choline-deficient and one control, deprived of the yeast and casein supplement for the last 14 days of the experiment showed a marked loss in body and uterine weight, while the non-nursing postpartum choline-deficient rat on a similar regimen appeared entirely normal.

The vaginal smears showed regular four-day estrous cycles in both experimental and control nonlactating females, and continuous diestrous smears in all nursing rats, broken by one or two estrous periods near the end of the experiment.

All uteri, on being excised and placed in Locke's solution at room temperature, contracted spontaneously and remained contracted until placed in warm (38° C) aerated Locke's solution. Immediate spontaneous contractions were recorded from every uterus, with no significant differences in rhythmicity or force of the contractions (Fig. 1).

The rate of contraction and general tonus were increased by both acetylcholine and posterior pituitary solution, while epinephrine caused a decrease in the general tonus and usually cessation of the spontaneous activity in all uteri (Fig. 1). These effects were readily reversed by replacing the drug-Locke's solution by a fresh Locke's solution.

The animals in these experiments represent a rather wide range of choline ingestion from adequacy downward. Although the nine controls received 30 mg of choline every second day in their diet, the nursing mothers were deprived of a considerable and variable portion of this supplement during the last three weeks of the diet on account of the inroads of their young at the food containers. The experimental animals were obtaining small amounts of choline from the yeast supplement (*3*). The particular product used here provided 3.6 mg of choline every second. The two experimental animals, one nursing and one nonlactating, which were deprived of the yeast and casein supplement for the last two weeks of the diet, probably achieved a true choline-deficiency, but achieved as well a deficiency in protein, biotin, para-aminobenzoic acid, inositol and perhaps other B-complex factors. However, in this widely varied series of 16 rats, spontaneous contractility and normal reactivity to hormonal and humoral agents were observed in all uteri, irrespective of their source.

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A New Method of Inoculating the Maydeae with Smut Fungi

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Corn seeds soaked in sporidial suspensions of three smuts of the Maydeae showed smut galls soon after germination. This proved to be a new method of infecting corn seedlings with the corn smut organism. The infestation technique employed was the same as that described earlier by the author (*1*) in obtaining seed and seedling infection of the grasses and cereals with *Xanthomonas translucens*. This discovery added another method of inoculating corn with species of Ustilago. The well known method of promoting infection with *Ustilago zeae* is to bring the sporidia or chlamydospores in contact with the growing point down in the spiral whorl or to inject the spores hypodermically into the tissues of the host. Seed infestation with sporidial suspensions in water merely constituted a surface contamination of the seed under favorable conditions for the growth and development of the parasite and the host. Apparently the fungus gained entrance into the host through the germinating seed and eventually reached the crown of the young developing seedling. Infection occurred only when the seeds were infested with sporidia and not with chlamydospores. Some seedlings were killed immediately after emergence. Others developed large swellings or galls, and still others were not attacked. This method of infection was not limited to *Ustilago zeae*. Infection was

TABLE 1

The Response of Sweet and Dent Corn Infested in Sporidial Suspensions of Three Species of Smut Fungi

Smut species	No. seeds infested	No. plants emerged	No. plants infected
		*Sweet corn**	
Ustilago zeae†	100	82	32
Ustilago dieteliana‡ on Tripsacum	260	210	81
Sphacelotheca reiliana from teosinte	360	322	0
		Dent corn§	
Ustilago zeae†	100	97	2
Ustilago dieteliana‡ on Tripsacum	420	400	29
Sphacelotheca reiliana from teosinte	360	348	0
		Teosinte‖	
Ustilago zeae†	40	25	0
Ustilago dieteliana‡ on Tripsacum	20	18	2
Sphacelotheca reiliana from teosinte	40	19	0

* Sweet corn variety Golden Bantam.

† *Ustilago zea* was collected near Ames, Iowa, and grown in single and mixed sporidial cultures for the infection trials.

‡ *Ustilago dieteliana* was collected by I. E. Melhus in 1946 near Mexico City, Mexico, on *Tripsacum latifolium*. Mixed sporidial cultures were used in the infection trials.

§ Dent corn commercial hybrid U. S. 13.

‖ Teosinte obtained from field near Chalco, Mexico.

Fig. 1. *Left*: healthy seedling; *middle*: seedling galled by Tripsacum isolate; *right*: seedling galled by corn isolate.

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[1] Present address: Division of Mycology and Disease Survey, U. S. Department of Agriculture, Ames, Iowa.

obtained with the sporidia of other smuts on corn and teosinte as indicated in Table 1.

The results of the seed infestation trials indicated that sweet corn was more easily infected when soaked in sporidial suspension than either dent corn or teosinte. Also, the response of the Tripsacum smut was like the corn smut organism in that *Ustilago dieteliana* occurring on *Tripsacum latifolium* was pathogenic on corn (Fig. 1).

Upon finding that galled seedlings developed from seeds infested in sporidial suspension, before planting a search was made for infected seedlings in field plots on land that had formerly grown corn. In the spring of 1946 infected seedlings from 4″ to 6″ tall were found. Subsequently a similar search was made in adjoining fields. Again infected seedlings were found. Most of these seedlings were killed before they were 8″ tall.

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The Semiquinone Radical of Tocopherol

L. Michaelis and S. H. Wollman[1]

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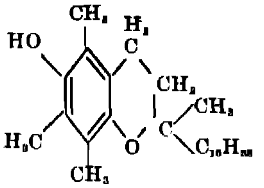
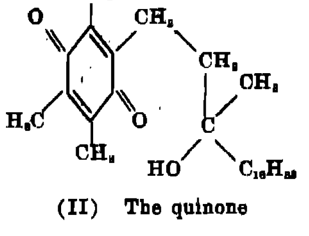
The structure of tocopherol (vitamin E) suggested the idea that its function both as a vitamin and as an antioxidant might be correlated to some reversible oxidation-reduction mechanism. However, this idea is difficult to reconcile with our present knowledge of the oxidation products of tocopherol (I). The first oxidation product attainable has the structure of a quinone (II) which can be reduced, but the reduction product is not the original tocopherol. The oxidation of tocopherol appears to be irreversible. To quote from a review of this problem (*6*), this fact "militates against the idea that the compound (viz. the quinone) enters into the utilization of the vitamin in the body through an oxidation-reduction process."



(I) α-Tocopherol



(II) The quinone

The antioxidant property of tocopherol is shared with hydroquinone (benzo-hydroquinone). The structure of tocopherol differs from that of hydroquinone and that of duro-hydroquinone (= tetramethyl hydroquinone) essentially in that it contains only one unsubstituted phenolic hydroxyl group, instead of two. This is why a reversible oxidation to a quinone cannot take place. This fact suggests that the antioxidant effect of hydroquinone may not be due to its reversible oxidation to quinone. However, the structure of tocopherol does not rule out the possibility of its reversible univalent oxidation to a semiquinone radical, which would arise from (I) by the removal of one electron only, in analogy to the semiquinone of duroquinone as described previously from this laboratory (*5*) and to many other semiquinones (*3*, *4*). This process would not involve opening the side-ring, as is necessary for the bivalent oxidation to the quinone and does not imply any irreversibility of the oxidation.

Such a hypothesis is difficult to prove for tocopherol because even if a radical is formed it may never accumulate to any concentration directly observable. The hypothesis would be made more acceptable, however, if one would succeed in making the free radical under certain artificial conditions at such a high concentration that one could easily detect it directly. For this purpose an ingenious method devised by G. N. Lewis (*2*) is helpful:

The substance in question is dissolved in an organic solvent which at the temperature of liquid air will form a homogeneous glass instead of crystallizing. It is irradiated, at the low temperature, in a Dewar flask through a quartz window, with ultraviolet light from a mercury lamp. Radiation may have two effects: It raises the energy level of some electron in the molecule, and when the excited state spontaneously returns to the ground state, there may be fluorescence, or phosphorescence, according to conditions; or irradiation may knock out an electron entirely and produce a free radical. Under ordinary conditions, the concentration of such a free radical would be restricted by the fact that thermodynamical equilibrium is established, for instance, due to dismutation of the radical. In most cases, the equilibrium is very much in disfavor of the free radical. At the low temperature in the rigid solvent, however, molecular collisions necessary to establish equilibrium are inhibited, and the free radical can accumulate to a concentration far above its thermodynamically permissible equilibrium concentration. The radical can be recognized by its characteristic color. On warming the system to a temperature somewhat above that of liquid air, the radical gets into the equilibrium concentration, which is extremely small. The color of the radical fades out on raising the temperature but can be preserved almost indefinitely as long as the vessel is kept at the temperature of liquid air.

With this method it has now been shown that tocopherol, dissolved in a mixture of alcohol, ether, and pentane, frozen and irradiated, develops with great ease and rapidity an orange-red color, showing characteristic absorption bands, which is stable at the temperature of liquid air even after stopping the radiation, but fades out on melting the frozen solution.

The color of the semiquinone of hydroquinone, prepared in the same way, is light yellow. This yellow substance is not quinone since it fades out on warming, but is the semiquinone radical. The monomethyl-ether of hydroquinone behaves as hydroquinone, which shows that one unsubstituted phenolic hydroxyl group is sufficient for the reaction and corroborates the assumption that the yellow color is not quinone.

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[1] Special research fellow of the National Cancer Institute.

There can be no doubt that this colored substance is a free radical existing in a concentration far above the thermodynamically permissible concentration. This experiment shows at least that the free radical of tocopherol is not just a product of paper chemistry but does exist. At ordinary temperatures, it will never accumulate to a directly recognizable extent. On the other hand, its very instability makes it a highly reactive substance.

Although the univalent oxidation may involve a large free energy, the process might be greatly facilitated if tocopherol were a prosthetic group of an enzyme and the process took place intramolecularly within the enzyme-substrate complex. Such an assumption would also fit the fact that the biological activity is restricted to a molecule of specific structure and is not exhibited generally by any mono-substituted hydroquinone.

It is not claimed that the problem as to the mechanism of the action of tocopherol either as a vitamin or as an antioxidant is entirely solved herewith. But the fact that the finding of the semiquinone places tocopherol in the class of the reversible oxidation-reduction systems establishes the analogy to various other vitamins which act as coenzymes or prosthetic groups of enzymes concerned with specific dehydrogenations, namely, riboflavin, nicotinic acid, and thiamine.

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Technique for Making Spreads of Omentum from Small Animals[1]

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Possibly one outcome of the work of Knisely's group (*2*) on sludged blood will be a re-awakened interest in the potential usefulness of the omentum in studies of the vascular system. Because the omentum is very thin, sectioning is unnecessary for microscopic studies, and so the observer can secure an unmutilated and complete survey of the vascular bed over a relatively wide field (*1*).

Smooth and sizable spreads of this tissue, however, are not easily obtained because as soon as the anchorage of the omentum to the intestine is destroyed, the mesentery tends to contract and wrinkle badly. The following technique routinely produces smooth spreads of omentum from mice (half grown to adults in size).

The tissue should be taken as soon after death as possible. The use of a duoloupe or dissecting microscope is advantageous. The intestine should be spread out so that a loop bounds a fan-shaped portion of the omentum, avoiding the region of the pancreas if very thin preparations are desired. A slip of cigarette paper (cut crosswise in about thirds) is placed on a gloved fingertip and inserted under the chosen portion of the omentum, retaining the fingertip beneath the omentum until the preparation is placed on a slide. The membrane is spread smoothly against the paper. Unless too much time has elapsed since the death of the animal, the albuminous substances in the tissue will affix it to the paper. The intestinal loop and enclosed "fan" are severed by fine scissors. The cut loop is carefully trimmed away from the enclosed membranous "fan" by cutting through the membrane and the supporting paper. The chosen portion of the paper-supported omentum is left balanced on the fingertip and then gently but firmly pressed with the tissue side down against the slide. Using scissors' tips or needles the spread is smoothed before it is covered with a few drops of fixing solution (we used Schaudinn's). After a delay of a second or so, the spread is blotted dry quickly by pressing with several layers of filter paper.

The next step requires speed, care, and skill. With a fine-pointed forceps for lifting the paper and a teasing needle or scissors' tip to hold the tissue against the slide, the cigarette paper is separated and peeled away. The slide with the affixed tissue should be placed in a jar of fixative immediately. Any of the usual techniques for fixing, dehydrating, and staining paraffin sections may be used for completing the preparation. If, as rarely happens, a spread slips from a slide during these later manipulations, the tissue may be salvaged by handling in the customary manner for "loose" celloidin sections.

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[1] Supported in part by grants from the U. S. Public Health Service and the Office of Naval Research.

Scanning Instrument for Quantitative One-Dimensional Paper Partition Chromatography

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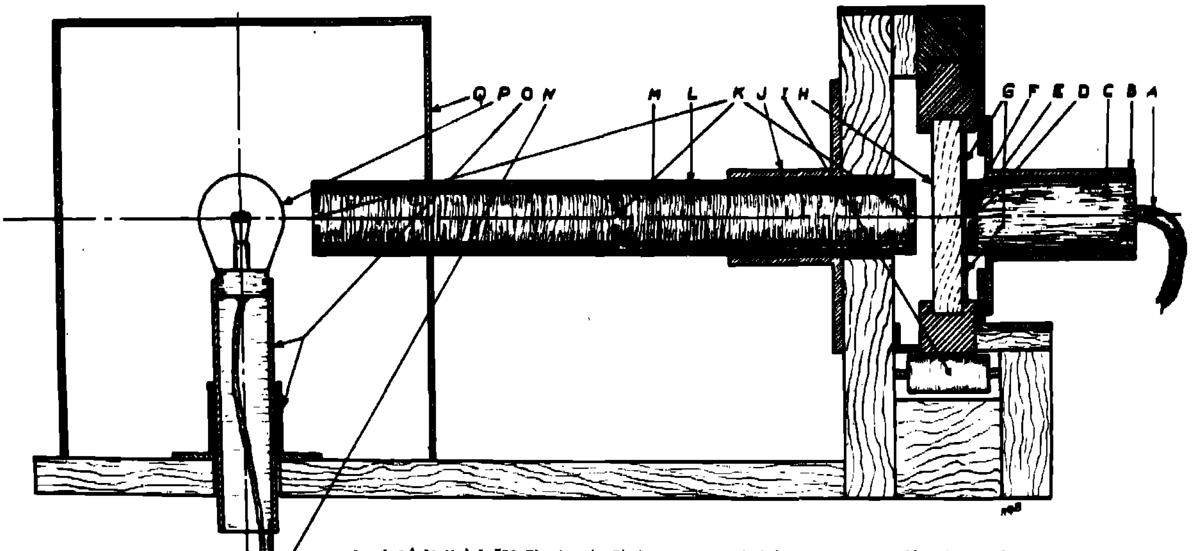
The method of Consden, Gordon and Martin (*3*) for separation and identification of amino acids by paper partition chromatography has found wide application and has been extended to other classes of compounds. Various methods for rendering the method quantitative have been described (*4, 5, 6, 7, 8, 9, 10, 11*). In this laboratory the method developed by Bull and coworkers (*2*)



A. Lead to Model 500 Electronic Photometer
B. Metal Housing for Photoelectric Cell
C. Model D Photoelectric Cell
D. Wratten Filter G15 (Eastman)
E. Window in Photoelectric Cell
F. Filter Paper Strip
G. Brass Masking Strip
H. Glass Slide
I. Supporting Roller
J. Metal Housing for Collimating Tube
K. Circular Apertures
L. Collimating Tube
M. Black Felt Lining
N. Leads to 6 Volt Transformer
O. Lamp Support
P. Lamp 32 Candle Power
Q. Metal Housing

FIG. 1.

on quantitative estimation of amino acids by one-dimensional paper partition chromatography is being used. This method, also developed by Block (*1*), depends upon the measurement of transmission of light through the filter paper strip containing purple spots developed by the reaction of ninhydrin on the individual amino acids on the strip.

The scanning instrument used in this laboratory for measuring transmission through the paper strips is shown in Fig. 1. The photoelectric cell, C, is connected by lead A to a photometer (Photovolt Corp.). The filter, D, is mounted in E, the cell window. The photoelectric cell fits snugly in the brass housing, B; the optimal distance between the paper strip and the cell can be adjusted by sliding the latter forward or backward in the housing. The housing, B, is held in place by four set screws (not shown) and is adjustable both horizontally and vertically to facilitate positioning the cell window, E, exactly in line with the collimated light beam passing through the paper strip, F. The glass slide, H, mounted in metal strips, moves horizontally on a series of supporting rollers, I. Brass strips, G, mask the entire surface of the glass slide except a narrow portion along the middle of the face of the slide covered by the filter paper strip, F. The light source, P, mounted on the vertically adjustable support, O, is connected by leads, N, to a 110 × 6-v transformer (not shown). The cylindrical housing, Q, encloses the light source. The cylindrical brass collimating tube, L, fits in the brass housing, J, and can be moved forward or backward for optimal adjustment. The three circular apertures, K, in the collimating tube consist of steel washers fitted into the tube. The inside of the collimating tube is lined with nonreflecting black felt, M. A scale, 70 cm in length, graduated from 0 to 100, is inscribed on the instrument frame adjacent to the top of the slide, and an indicator line on the slide frame is used to read the scale. In practice all strips are run in the vapor chamber to a total distance of 70 cm (*i.e.*, a distance equal to the length of the scale on the scanning instrument). The color is developed on the strips (*2*) which are then fastened in the proper position on the glass slide between the brass masking strips. Transmission readings are taken at intervals of ½ scale units (1 scale unit = 0.7 cm) by moving the slide. The transmission readings from the Photovolt meter are plotted directly upon semilog paper as a function of distance in scale units, and the curves treated as described by Bull (*2*). Using this method the R_f value (*3*) can be read directly from the plot.

Accuracy of determinations of amino acids using color development with ninhydrin by Bull's method (*10*) vary for us from 5 to 15% depending upon the amino acid.

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The Use of Ion Exchange for the Determination of Radioelements in Large Volumes of Urine[1]

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The efficacy of ion exchange as a means of extracting, concentrating, and purifying cations and anions from large volumes of solutions is well known. Inasmuch as the determination of radioelements or trace elements in urine involves similar problems it was felt that analogous adsorption procedures could be applied. Numerous studies had already demonstrated the ability of ion exchangers to extract ions, particularly calcium, from biological fluids (*1*). Our objective was to extract quantitatively a trace element from a liter or more of urine and concentrate it in a few ml of a solution completely free from the large concentration of salts which usually interferes with spectrographic and chemical methods of analysis.

In connection with various metabolic studies it was desirable to determine quantitatively the concentrations of fission products in urine, especially with regard to relating the urinary levels of radioelements to body content. Since the rare earths constitute an important fraction of the fission products, the determination of these elements in urine by using a cation exchanger was attempted. Carrier-free radioyttrium, Y^{91}, was chosen as a tracer element for these studies. An extensive investigation of optimum conditions was made, but only the most recent workable flow sheet is presented.

The principles involved in the adsorption and desorption of a cation from an organic cation exchanger are discussed elsewhere (*2*, *3*). Essentially the cation exchange reactions follow the law of mass action. A given reaction, then, can be made to proceed in any direction by altering the relative concentration of the reactants and products. In this adsorption process for extracting and subsequently eluting yttrium from urine, the principal reaction for both the adsorption and desorption steps is:

$$Y^{+++} + 3HR \underset{\text{Desorption}}{\overset{\text{Adsorption}}{\rightleftharpoons}} YR_3 + 3H^+,$$

in which the symbol *R* represents the nondiffusible anionic part of the cation exchanger.

The adsorption of the yttrium is made from urine, 0.1 M in HCl, while the desorption is carried out with 7 M HCl. Briefly, the adsorption process consists of passing a liter of acidified urine containing tracer yttrium through an adsorption column of a cation exchange resin, removing the extraneous calcium and other cations with 0.4 M HCl, and subsequently eluting the adsorbed Y^{+3} with a small volume of 7 M HCl. The 7 M HCl is evaporated to near dryness to remove the bulk of the acid, while remaining organic matter is destroyed by wet ashing with nitric acid. The residue is transferred quantitatively with distilled water to a 10-ml capacity porcelain capsule, evaporated to dryness under an infrared bulb, and the radioactivity is measured directly with an end mica-window Geiger-Müller counter.

If the radiations from a particular radioelement are not very penetrating, it is necessary that the last traces of salts be removed. With Y^{+3}, for example, it is possible to dilute the ashed residue with distilled water and pass it through a second column of adsorbent which contains only $\frac{1}{17}$ by weight as much resin as is present in the first column. The adsorbed Y^{+3} is eluted with 60 ml of 7 M HCl. When evaporated to dryness, mounted on a flat platinum plate, and flamed, this solution leaves, in most cases, no perceptible residue.

The advantages claimed for the method are: (1) no preparation of the urine other than acidification is necessary; (2) no close control of pH is required; (3) the operation may be interrupted at any stage desired; (4) one technician can run several samples simultaneously; and (5) the equipment and adsorbent, once set up, may be used repeatedly.

Amberlite IR-1 resin[4] is employed in the first column adsorption step while a more insoluble resin, Amberlite IR-100H, is used in the second step because it helps to minimize the amount of solid matter associated with the yttrium. The weights of resin are expressed in terms of the air-dried hydrogen form. Now that more insoluble and higher capacity resins, such as Dowex 50[5] (*2*) and Amberlite IR-120, are available it would be definitely advantageous to substitute them for IR-1 and IR-100H after making allowances for the capacity and kinetic characteristics of these new resins (*2*, *4*).

The glass columns are set up in the usual manner. Glass wool serves as a satisfactory support for the resin bed. A straight glass stopcock is used to regulate the flow rates. A 2-l leveling bottle serves as a storage tank for liquids percolating through Column I while a 500-ml leveling bottle suffices for Column II. About 2′ of head is found to provide satisfactory flow rates. The urine was "spiked" with carrier-free Y^{91} and then acidified as specified in the flow sheet.

The accompanying flow sheet (Fig. 1) provides all the details of the operations necessary for the extraction and concentration of Y^{91} from liter volumes of urine. Larger volumes of urine can be handled by a proportionate increase in the mass of resin employed. The resin is ready for a new run at the end of each cycle.

The functions of the different solutions employed are as follows:

(1) The acidification of the urine prevents the precipitation of calcium salts, keeps the yttrium in ionic form,

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[1] The work reported here is based on studies completed in the autumn of 1045 and is scheduled for publication in Vol. 16A of the Plutonium Project Record.

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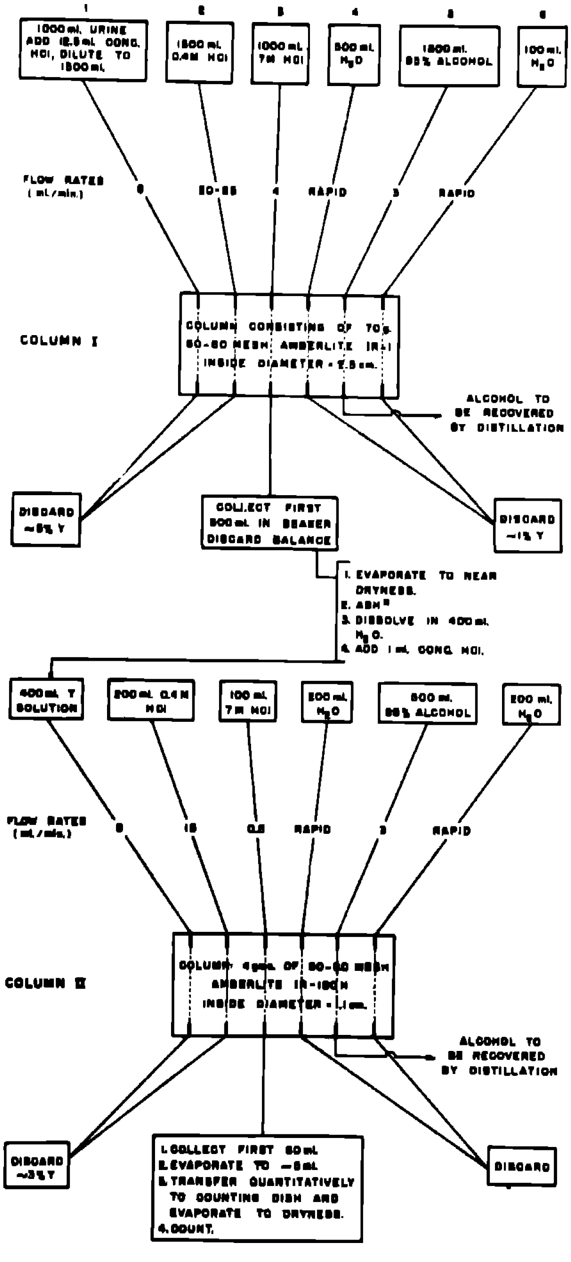
[3] Present Address: Oak Ridge National Laboratory, Oak Ridge, Tennessee.

[4] Manufactured by the Resinous Products Chemical Co., Washington Square, Philadelphia, Pennsylvania.

[5] Manufactured by Dow Chemical Co., Midland, Michigan.


1
1000 ml. URINE ADD 12.5 ml. CONC. HCl, DILUTE TO 1500 ml.
2
1500 ml. 0.4M HCl
3
1000 ml. 7M HCl
4
500 ml. H2O
5
1500 ml. 95% ALCOHOL
6
100 ml. H2O
FLOW RATES (ml/min.)
8
20-25
4
RAPID
3
RAPID
COLUMN I
COLUMN CONSISTING OF 70 g. 50-60 MESH AMBERLITE IR-1 INSIDE DIAMETER - 2.5 cm.
ALCOHOL TO BE RECOVERED BY DISTILLATION
DISCARD ~5% Y
COLLECT FIRST 500 ml. IN BEAKER DISCARD BALANCE
DISCARD ~1% Y
1. EVAPORATE TO NEAR DRYNESS.
2. ASH*
3. DISSOLVE IN 400 ml. H2O.
4. ADD 1 ml. CONC. HCl.
400 ml. Y SOLUTION
200 ml. 0.4 N HCl
100 ml. 7M HCl
200 ml. H2O
500 ml. 95% ALCOHOL
200 ml. H2O
FLOW RATES (ml./min.)
8
15
0.5
RAPID
3
RAPID
COLUMN II
COLUMN 4 gms. OF 50-60 MESH AMBERLITE IR-100H INSIDE DIAMETER - 1.1 cm.
ALCOHOL TO BE RECOVERED BY DISTILLATION
DISCARD ~3% Y
1. COLLECT FIRST 50 ml.
2. EVAPORATE TO ~5 ml.
3. TRANSFER QUANTITATIVELY TO COUNTING DISH AND EVAPORATE TO DRYNESS.
4. COUNT.
DISCARD

*The solution, contained in a 1 liter beaker, is evaporated on a hot plate to near dryness. The organic residue is destroyed by the addition of about 50 ml. of [illegible] HNO$_3$ and evaporated to dryness. This treatment is repeated at least two more times. Finally to the ashed material is added 10 ml. of [illegible] HNO$_3$ and the mixture is evaporated to near dryness.

FIG. 1. Flow sheet for the determination of radio-yttrium, Y^{91}, in human urine by cation exchange.

and breaks up any unadsorbable complexes that yttrium may form with urinary constituents.

(2) The 0.4 N HCl removes some adsorbed organic matter as well as calcium and other monovalent and divalent cations.

(3) The 7M HCl serves to elute the yttrium quantitatively in a small volume.

(4) The 95% alcohol removes remaining organic matter. This step was introduced when it was found that the adsorption of yttrium from liter quantities of urine kept decreasing, *i.e.*, the break-through point was quite erratic and as much as 35% of the yttrium lost. It was presupposed that alcohol-soluble organic matter coated the resin particles so that the adsorption of yttrium was hindered. The alcohol wash was found to prevent the premature break-through of yttrium.

The adsorption method as it now stands gives consistent recoveries of Y^{91} of 90 ± 5% when only Column I is utilized, and an over-all recovery of 85 ± 5% if the process includes Column II. It is possible to improve this recovery by closer control of variables. The effect of yttrium concentration on its adsorption by the resin may be calculated (*4*). In the present process it appears that about 10^{-4} M of yttrium can be extracted with no loss in efficiency.

Because the concentrations of substances such as albumin and urea which normally appear in urine are quite variable, it was desirable to ascertain their effects on yttrium adsorption.

Albumin: The presence of albumin in urine as high as 2 gm/l had no observable effect.

Urea: In the range of concentration studied, 0–4.0 gm of urea/100 ml of urine had no effect on yttrium adsorption.

Acids: The equilibrium adsorption of yttrium by IR-1 from urine acidified with each of the following acids was studied: acetic, sulfuric, hydrochloric, and nitric in concentrations ranging from 0.1 N to 1.0 N. The maximum adsorption (which was about the same for the various acids) was obtained when the solutions were 0.1–0.2 N. Higher concentrations of acids caused a marked decrease in yttrium adsorption.

Sodium chloride: Concentrations of NaCl up to 1.2% did not reduce the adsorption of yttrium.

In general, the scheme given here will be found suitable for the extraction and concentration of other cations with a valence of +3 or greater. The processing of divalent cations such as Ba^{++} and Ra^{++} would involve a closer attention to the concentration and volume of the HCl-eluting solution in order to remove selectively urinary calcium. Chromatographic complex elution with citrate solutions can, of course, be utilized for the separation of calcium from other divalent cations (*4*). For metals which easily form complex anions, such as chromium, gold, and molybdenum, for example, an anion exchange system (*5*) may be found useful.

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Book Reviews

Advances in food research. (Vol. I.) E. M. Mrak and George F. Stewart. (Eds.) New York. Academic Press, 1948. Pp. xv + 459. (Illustrated.) $7.50.

This book contains reviews on the following subjects: the physiology and chemistry of rigor mortis, with special reference to the aging of beef; factors influencing the vitamin content of canned foods; the physiological basis of voluntary food intake (appetite); biochemical factors influencing the shelf life of dried whole eggs and means for their control; factors affecting the palatability of poultry with emphasis on histological post-mortem changes; deterioration of processed potatoes; the influence of climate and fertilizer practices upon the vitamin and mineral content of vegetables; nonenzymatic browning in fruit products; microbial inhibition by food preservatives; and high-polymer pectins and their deesterification.

Each of the reviews is accompanied by a suitable bibliography to the sources of information on which it is based. Every contributor is an experienced investigator in his segment of food research.

~~Researches on foods have been~~ accelerated by the great advances in our knowledge of biochemistry and the biological sciences. Original communications are scattered in journals devoted to biochemistry, bacteriology, mycology, and nutrition. Technologists, researchers, and teachers find it almost impossible to examine the original literature which bears upon their interests. In various fields of knowledge the annual volume devoted to thorough reviews and criticism has done much to assist those interested in keeping informed about research progress. The references help them to find readily what they most need to examine at first hand. The present volume is an excellent addition to the list of special volumes devoted to advances in special fields of knowledge.

E. V. McCollum

Johns Hopkins University

A textbook of heat for upperclassmen. LeRoy D. Weld. New York: Macmillan, 1948. Pp. x + 437. $5.00.

As explained by the author in the preface, "The content of this book is based upon material which the author has been using, with frequent revisions, as lecture notes in a junior-senior course in heat for the past thirty-five years." A lot of ground is covered: calorimetry, dilatometry, phase transitions, properties of gases, kinetic theory of gases, thermodynamics, properties of mixtures, heat transfer, and thermometry. In less than 400 pages of actual text, many of these topics could be given only brief mention.

The author has an easy, fluent style. His explanations and examples are lively and interesting. There are many well-drawn graphs, some of them to scale. The best material in this reviewer's judgment is that on kinetic theory—the poorest on the foundations of thermodynamics. It is to be regretted that the author has retained the old-fashioned point of view with regard to the use of the term "heat"—a point of view at variance with current usage by physicists, chemists, and engineers. One cannot help but complain also about the author's symbolism which ignores almost completely the published lists printed in the *American Journal of Physics* and elsewhere. There is no excuse, in these times, for using complicated bold-face Gothic characters for thermal capacity, efficiency, resistance, etc.

Mark W. Zemansky

City College of New York

Scientific Book Register

Barnes, H. F. *Gall midges of economic importance: gall midges of ornamental plants and shrubs.* (Vol. IV.) London: Crosby Lockwood, 1948. Pp. 165. (Illustrated.) 15/–.

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NEWS and Notes

National Science Foundation. On March 18, the Senate passed S. 247, the "National Science Foundation Act of 1949." On the same date, the Public Health, Science, and Commerce Subcommittee of the House Interstate and Foreign Commerce Committee announced that hearings on the National Science Foundation bills will be scheduled for March 31, April 1, and April 4 at 10:00 a.m. As noted in the March 18 issue of *Science*, one of the chief purposes of the hearings is to familiarize new Subcommittee members with the legislation, but Congressman J. Percy Priest has invited all interested organizations and individuals to present their views.

By invitation of Congressman Priest, the Inter-Society Committee for a National Science Foundation will be represented by Dael Wolfle, secretary-treasurer of the Committee; and the AAAS will have Howard A. Meyerhoff, administrative secretary, and Raymond L. Taylor, assistant administrative secretary, present to answer any questions the House Subcommittee may ask. Such support as these three representatives can give to a National Science Foundation Bill will be greatly strengthened by letters from scientists addressed to members of the House Subcommittee (see *Science*, March 18, p. 295).

Members of the Subcommittee on Public Health, Science and Commerce have six bills before them for consideration. H. R. 12, 185, 311, 1845, and 2308 differ only in minor details from H. R. 6007 of the 80th Congress and from the Senate bill S. 247. Sponsors of these bills are: *For H. R. 12,* J. Percy Priest (6th District, Tennessee); *for H. R. 185,* Oren Harris (7th District, Arkansas); *for H. R. 311,* Charles A. Wolverton (1st District, New Jersey); *for H. R. 1845,* James E. Van Zandt (22nd District, Pennsylvania); *for H. R. 2308,* Wilbur D. Mills (2nd District, Arkansas). For all practical purposes these five bills may be considered as a single piece of legislation, which will receive the united support of their respective proponents. The only rival bill is H. R. 359, introduced by Emanuel Celler (15th District, New York). This bill closely follows the pattern set by S. 1850 of the 79th Congress, which, though supported by many of the nation's scientists, was the subject of vigorous controversy.

Only once (1947) has a National Science Foundation bill passed the House. If scientists wish to insure passage of a bill in 1949, it will help if they express themselves to their Congressmen, to the proponents of these six bills, and to the members of Mr. Priest's Subcommittee, not only in support of the Foundation, but also in regard to the kind of Foundation they want.

HOWARD A. MEYERHOFF

About People

Clark B. Millikan, professor of aeronautics, California Institute of Technology, has recently been named director of the Daniel Guggenheim Laboratory of Aeronautics and chairman of the Jet Propulsion Laboratory Board at Caltech.

Milan V. Novak has been appointed assistant dean of the Graduate College for the University of Illinois' Chicago Professional Colleges. Dr. Novak will continue to serve as professor of bacteriology and head of the Department.

J. William Hinton, a professor of clinical surgery on the New York University medical faculty since 1944, has been appointed professor of surgery at the Post Graduate Medical School, New York University-Bellevue Medical Center. Dr. Hinton will be director of the fourth surgical division at Bellevue and will continue as director of surgery at University Hospital.

Henry G. Booker, professor of electrical engineering at Cornell University, has been elected Honorary Fellow of the Geophysical Observatory, University of Alaska. This citation honors him for his work on microwave propagation and electromagnetic wave propagation in the upper atmosphere.

The National Bureau of Standards announces two appointments to the staff: **Charles A Mabey**, former director of research for the Bristol Company, will supervise electronic miniaturization, circuits, and processes as assistant chief of the Engineering Electronics Laboratory; and **Paul Wang**, former dean of the Physics Department, Shantung University, China, will do research in X-rays and nuclear physics, specializing in betatron and high-voltage equipment.

Douglass Poteat, former executive vice president of the American Cancer Society, has recently been appointed executive vice president of Memorial Hospital Center for Cancer and Allied Diseases in New York City.

Edward O. Hulburt, former superintendent of the Optics Division, Naval Research Laboratory, Washington, D. C., has been made director of research of the Laboratory.

Grants and Awards

The Institute of Medicine of Chicago is offering the Joseph A. Capps prize of $400 for the best paper on a medical study or a problem closely related to medicine. The competition is open to graduates of Chicago medical schools who completed their internship or one year of laboratory work during 1947 or later. Manuscripts must be submitted to the Secretary of the Institute of Medicine of Chicago, 86 East Randolph Street, Chicago 1, not later than *December 31*.

The Commonwealth Fund has awarded an advanced medical fellowship to David Glick, associate professor of physiological chemistry, University of Minnesota Medical School, to study developments in histo- and cytochemistry at the Carlsberg Laboratory in Copenhagen and the Kaolinska Institute in Stockholm during the summer.

Elwood C. Zimmerman, associate entomologist, Experiment Station, Hawaiian Sugar Planters' Association, and curator of entomology, Bishop Museum, was awarded the 1948 literary prize of $250 by the Friends of the Library of Hawaii for his five-volume work "Insects of Hawaii." This is the first time a scientific treatise has been given the award.

The Institute of Radio Engineers gave its Fellow Award this year to **John N. Dyer**, supervisor of radar and air navigation research and development for Airborne Instruments Laboratory, Mineola, Long Island, New York. Mr. Dyer was honored for his contributions to radio, including polar expedition communications and wartime radio counter measures.

Sigma Delta Epsilon, national women's scientific fraternity, has awarded its $1,200 predoctoral fellowship for 1949–1950 to **Irene T. Kline**, Western Reserve University, Cleveland, Ohio. Miss Kline in investigating possible relations of known vitamins to the biochemical mechanism of steroid hormone action.

The University of Pennsylvania has received $100,000 from Lit Brothers, Philadelphia department store. A major portion of the gift will be used for the development of the University's new Medical Center. This latest donation brought the total gifts and pledges to the University's development fund to more than $4,000,000.

Fellowships

The National Paraplegia Foundation is offering a limited number of fellowships for research in spinal cord disease and trauma and assiciated complications. These $3,000 fellowships are open for the academic year 1949–1950 to any candidate who has demonstrated a capacity for medical research and has outlined a meritorious program of study. Application forms may be obtained from L. W. Freeman, Chairman, Medical Advisory Committee, National Paraplegia Foundation, Room 457, Hotel La Salle, Chicago 2, and must be submitted not later than *June 1*.

The Jessie Horton Koessler Fellowship of the Institute of Medicine of Chicago will be available September 1. Established for the aid of research in biochemistry, physiology, bacteriology, or pathology, the fellowship carries a stipend of $500 a year, with the possibility of renewal for one or two years. Applications must be approved by the head of the department in the fields mentioned or by the director of a research institute or laboratory in Chicago, and must stipulate that the applicant will have adequate facilities for carrying out the proposed research. A letter presenting full information should be sent in quadruplicate to Paul R. Cannon, Committee Chairman, 950 East 59th Street, Chicago 37, not later than *July 1*.

Colleges and Universities

Ohio State University College of Dentistry will hold a post-collegiate assembly April 27–28. Dental progress since World War II will be reviewed by members of the faculty, assisted by Charles Williams, University of Toronto, and Robert Hardy of Tufts Dental College.

The Massachusetts Institute of Technology is offering a new graduate program in analytical chemistry. Planned to meet new needs in industry and teaching, the course emphasizes instrumental methods, particularly radiochemical analysis. Assistantships and scholarshpis are available, and information may be obtained from the Head of the Department of Chemistry, Massachusetts Institute of Technology, Cambridge 39.

The University of Washington is conducting basic research toward developing a simple method for locating warm levels in extreme low-temperature areas. The investigation, carried on under a $6,000 grant from the U. S. Army Quartermaster General's Office, will be used in locating arctic camps, supply dumps, and air fields. Phil E. Church, head of the department of meteorology and climatology is directing the study, and Robert G. Fleagle, assistant professor, is in charge of the preliminary work.

Vassar College has awarded full-year faculty fellowships to **Edward R. Linner**, associate professor of chemistry, and **Monica Healea**, associate professor of physics. Professor Linner will continue a study of absorption from solution, in England or Sweden, and Professor Healea will do research at Vassar in the field of secondary emission.

Summer Programs

Duke University Marine Laboratory, Beaufort, North Carolina, will open its twelfth summer session on June 14. Courses in marine algae and marine ecology will be offered during the first six weeks and courses in plant ecology and marine invertebrate zoology during the second six weeks. They are open to graduate students and seniors only. Further information may be obtained from the Director of the Laboratory, Box 269, Beaufort, North Carolina.

The Oak Ridge Institute of Nuclear Studies' Special Training Division will conduct three basic courses in the techniques of using radioisotopes as tracers, June 6–July 1, July 11–August 5, and August 8–September 2. Thirty-two participants will be accepted for each course, and applications should be mailed prior to *June 1*. Forms and additional information may be obtained from Ralph T. Overman, Chairman, Special Training Division, Oak Ridge Institute of Nuclear Studies, P. O. Box 117, Oak Ridge, Tennessee.

The University of Michigan's summer symposium on contemporary physics will be held from June 27 to July 30. Guest lecturers will include: Luis W. Alvarez, University of California—"Recent Experiments in High Energy Physics," June 27–July 9; R. P. Feynman, Cornell University—"Problems in Quantum Electrodynamics," July 11–July 30; Frederick Seitz, Carnegie Institute of Technology—"Special Topics of the Theory of Solids," June 27–July 23; and G. B. B. M. Sutherland, Cambridge University—"Current Developments in the Infrared in the Physical, Chemical, and Biological Fields," July 5–July 30. Further information may be obtained from E. F. Barker, Chairman, Department of Physics, University of Michigan, Ann Arbor.

The Roscoe B. Jackson Memorial Laboratory, Bar Harbor, Maine, will hold its regular summer student training program June 22–August 30. Two concurrent 10-week courses in research problems, techniques, and progress in the field of growth or of behavior will be offered. Enrollment is limited to 22 students to be selected on the basis of scholarship and interest in particular fields. Further information may be had by writing to the Chairman, Summer Student Program, Jackson Laboratory, Bar Harbor, Maine. Applications must be in by *April 1*.

Meetings and Elections

Wilder Graves Penfield, professor of neurology and neurosurgery, McGill University, Montreal, will present the **Edward K. Dunham lectures** for the promotion of medical sciences, at Harvard Medical School, March 28 and 30, and April 1. His subject will be "The Cerebral Cortex of Man." The lectures, to which all interested professional persons are invited, will be held at 5:00 p.m. at the Harvard Medical School Amphitheater, Building D.

A conference on **Mathematical Models in the Social Sciences,** under the joint sponsorship of the Department of Mathematics and the Laboratory of Social Relations of Harvard University, will be held March 28 and 29, at 4 p.m. and 8 p.m., in Emerson Hall, Room D, Harvard University. Speakers will be N. Rashevsky, University of Chicago; John Von Neumann, Institute for Advanced Study; and Norbert Wiener, Massachusetts Institute of Technology.

The American Mathematical Society will hold its 445th meeting April 1–2, at Duke University, Durham, North Carolina. Sessions will be held in Rooms 114 and 117, Physics Building. Registration headquarters will be in the lobby of the Men's Union, West Campus. Hotel reservations should be made directly with the hotels.

The Association of Geology Teachers will hold its ninth annual meeting April 22–23 at Rosenwald Hall, University of Chicago. The program includes the presentation of papers on geological education and field excursions. Nonmembers wishing to attend should communicate with Katherine F. Greacen, Secretary, Department of Geology, Milwaukee-Downer College, Milwaukee.

Yale University's Silliman Memorial Lectures are being delivered this year by Ross G. Harrison, director emeritus of the University's Osborn Zoological Laboratory. The subject of the six lectures is "Organization and Development of the Embryo," and the forthcoming four will be held at 4:30 p.m., March 25, 30, and 31, and April 1, in Strathcona Hall on the campus.

The Cardiovascular Study Section of the National Institutes of Health, Public Health Service, will hold a **Symposium on Water and Electrolyte Metabolism in Cardiac Edema** at Hotel Haddon Hall, Atlantic City, on April 30. E. Cowles Andrus, of Baltimore, is chairman of the section. Those who expect to attend should communicate with Eleanor M. K. Darby, Executive Secretary, National Institutes of Health, Bethesda, Maryland.

The American Institute of Chemical Engineers will hold its regional meeting May 9–11 at the Mayo Hotel, Tulsa, Oklahoma. The program includes four symposia on primary energy, chemicals from petroleum, oil and gas production, and chemical engineering economics. Additional information may be obtained from Clifton Frye, Research Department, Stanolind Oil and Gas Company, Tulsa.

David J. Finney, lecturer on the design and analysis of scientific experiment, University of Oxford, will give three lectures on "Statistical Principles of Biological Assay" at the U. S. Department of Agriculture Graduate School. The lectures, sponsored by the Department of Mathematics and Statistics, will be held June 3, 6, and 7 from 4:00 to 5:30 p.m. in the Jefferson Memorial Auditorium, South Agriculture Building, Washington, D. C. The public is invited.

The Genetical Society of Great Britain will hold its 100th meeting June 30–July 1, in Cambridge. Guest speakers will review the early days of genetics and demonstrate genetical work now in progress in Great Britain. All geneticists are cordially invited. Details may be obtained from the secretaries, G. Pontecorvo, Department of Genetics, The University, Glasgow, W. 2., and H. G. Callan, Institute of Animal Genetics, The University, Edinburgh 9.

Mining Engineers in San Francisco. In celebration of the centenary of the Gold Rush, mining engineers, economic geologists, and metallurgists assembled in San Francisco February 13–17 for the 168th general meeting of the American Institute of Mining and Metallurgical Engineers. The Society of Economic Geologists met jointly with the Institute. Members of the U. S. Section of the Pan-American Institute of Mining Engineering and Geology gathered informally for luncheon, but arranged no special program.

William E. Wrather, treasurer of the AAAS, who has served the Institute as president during the past year and acted as presiding officer at general sessions and business and directors' meetings, relinquished the post to L. E. Young, incoming president for 1949. Howard A. Meyerhoff, administrative secretary of the AAAS, took office as chairman of the Industrial Minerals Division for the year 1949.

A record crowd divided its attention among 60 technical sessions, divisional luncheons, and social functions, and heard speeches by Governor Earl Warren at the All-Institute luncheon, and by Robert Gordon Sproul, president of the University of California, at the annual banquet. Noteworthy among the sessions were symposia on national mineral policy and atomic mineral deposits. None of the technological developments which make the mining and metallurgical professions dynamic was neglected, but programs and papers dealing with economics in the Industrial Minerals, Petroleum, and Coal Divisions gave clear indication that even the experts recognize that technology is not enough, and that the engineer must broaden his horizon to embrace the remotest economic factors which affect his operations.

The engineers honored distinguished colleagues, awarding medals to Harry Carothers Wiess (posthumously), Stanly A. Easton, William Wraith, and Eugene McAuliffe. Prizes and other awards for research went to M. Tenenbaum, E. A. Gulbransen, and J. W. Hickman (posthumously), John D. Saussaman, and Robert L. Hoss. Little time was allotted to field Activities, but the visiting engineers were given a courtesy flight over the San Francisco Bay area by Pan American Airways.

Plans for 1949 were laid in business sessions, and a regional meeting was announced for September in Columbus, Ohio. The next annual meeting will be held at New York, in February, 1950.

HOWARD A. MEYERHOFF

Deaths

W. Reid Blair, 74, zoologist, died March 1 in New York City of a heart attack. Dr. Blair retired in 1940 as director of the New York Zoological Society's Bronx Zoo, where he had served for 32 years.

Theodore M. Focke, 78, former dean of Case Institute of Technology, died March 2 in Cleveland, Ohio. A Case faculty member for nearly 52 years, Dr. Focke was appointed professor of mathematics in 1908 and was dean of the Institute from 1918 until his retirement in 1944.

Leon Hastings Cornwall, 62, neurologist and member of the faculty at the College of Physicians and Surgeons, Columbia University, died at White Plains, New York on March 4.

Franklin S. Newell, 77, gynocologist and professor emeritus of clinical obstetrics at Harvard Medical School, died in Boston March 4.

Edwin H. Colpitts, 77, electrical engineer, died March 6 in East Orange, New Jersey. Dr. Colpitts played a major part in the development of telephone and radio communication and in the establishment of trans-Atlantic telephone service.

New Yorkers were flocking to the beach just about three months early when the New York Botanical Garden's exhibit, **"Plants Beside the Sea,"** opened March 21, at the International Flower Show, Grand Central Palace. Showing the characteristic northeast coastal plants of North America, which have adapted themselves to wind, salt, and sand, the Botanical Garden's presentation will include a miniature beach, replete with seaside cottage, cliffs, lapping waves, and sandy shoreline, as well as grass, heather, pines, and other plants found near the ocean. This month's issue of the Botanical Garden's *Journal* carries an article listing more than 100 seacoast flowers —"Wild Flowers of Our Coastal Lands," by E. J. Alexander. Single copies may be ordered for 15 cents from the Botanical Garden, Bronx Park, New York City 58.

The American Museum of Atomic Energy was opened to the public on March 19, when the gates to the city of Oak Ridge were removed. The exhibit is the first step in a broad program of public education in the field of atomic energy taken by the Oak Ridge Institute of Nuclear Studies, which heretofore has confined its activities to highly specialized research and training in the nuclear sciences. The "Man and the Atom" show, originally presented at the New York City Golden Jubilee last summer, forms the nucleus of the Museum. A staff is being assembled under the direction of David Lloyd DeJarnette, who has taken a year's leave of absence from his post as curator of the Alabama Museum of Natural History for the purpose. Admission fees will be used to expand and improve the exhibits.

Scholars from overseas who visit Boston are invited to visit the **American Academy of Arts and Sciences,** 28 Newbury Street, Boston 16, Massachusetts. The staff of the Academy will be glad to arrange travel and hotel accommodations and introductions to scholars and institutions in the Boston district. Mail and telephone calls may also be received at the Academy.

Harvard University's Peabody Museum has announced the discovery of an engraved pebble believed to be the finest example of Aurignacian engraving thus far discovered by archaeologists. The pebble was found last summer during excavations at La Colombiere rock-shelter, above the Ain River in eastern France, in an occupation layer immediately overlying the terrace that contained the relics of the Upper Aurignacian period, which places its age at 20,000 to 25,000 years. It is limestone, about the size of a large potato, and covered on both upper and lower surfaces with a number of engravings superimposed one over the other. Archaeologists have outlined a rhinoceros, horse, ibex, bison, and deer, as well as other partially drawn animals. They believe that the stone was used over and over again to insure good hunting. Excavations leading to the discovery were made by Hallam Movius, Jr., curator of paleolithic archaeology, and Kirk Bryan, professor of physiography, of Harvard University, with the assistance of Louis Dupree and Carleton Pierpont of Harvard, and S. Sheldon Judson, of the University of Wisconsin.

Water-tight tile walls are possible through the use of a dense well-graded mortar applied in well-filled joints, the Office of Technical Services of the Department of Commerce reports. University of Minnesota researchers, who made the study under the OTS industrial program, exposed sample tile wall sections to simulated conditions of wind and rain to find the best ways to prevent wall leakage during prolonged exposure. They found that the bond between tile and mortar has key significance in the water-resistance of a wall, and is more important than the kind of tile used. A copy of the report, PB94388, *Water permeability of structural clay tile facing walls,* may be ordered from the Office of Technical Services, Department of Commerce, Washington 25, D. C. The price is $1.00 and checks or money orders should be payable to the Treasurer of the United States.

Make Plans for—

Michigan Academy of Science, Arts, and Letters, March 31–April 2, Wayne University, Detroit.

2nd Symposium on Plasticity, sponsored by the Navy Department's Bureau of Ships and Office of Naval Research, April 4–6, Brown University, Providence, Rhode Island.

Meeting of the Animal Disease Research Workers in The Southern States, April 7–8, Alabama Polytechnic Institute, Auburn.

Crystallographic Society of America, fourth annual spring meeting, April 7–9, University of Michigan, Ann Arbor.

Eastern Psychological Association, annual meeting, April 8–9, Springfield, Massachusetts.

Medical Library Association, annual meeting, April 10–14, Galveston, Texas.

The Responsibility of the Anthropologist

Harry L. Shapiro

American Museum of Natural History, New York City

TWENTY-FIVE YEARS AGO the number of professional anthropologists in this country was so small that the Anthropological Association at its 1922 meeting at Cambridge was comfortably seated in its entirety, along with guests and undergraduates, in one of the classrooms of the Peabody Museum.

In those antediluvian days, anthropology in the academic hierarchy was rated an exotic and marginal subject and at Harvard, at any rate, where I was doing my graduate work, it was relegated with the Semitic Museum and the Divinity School to the fringes of the University. Lacrosse and fencing occupied somewhat the same place in athletics—that is, they were considered nice extras to attract the few nonconforming spirits that did not find the more important football or track to their taste. Anthropology was not expected to pay its way, but also it was not permitted to place a noticeable strain on the university budget.

The literate public was, of course, no better acquainted with the subject. All of us had our hands full trying to explain to our friends and relatives just what anthropology meant. I remember my mother reporting with much amusement a conversation with a friend of hers who had politely inquired concerning my activities. My mother told her I was studying anthropology. "How nice," the friend commented, and, after a pause, "Just what is anthropology?" Those were the days when an ethnologist studied primitive cultures and personality was something you wished you had.

We were few and neglected, beggars for crumbs at the foundational banquets where the seated guests were physicists, chemists, biologists and economists and all the other anointed. We pursued our tasks in obscurity and our lines were heard only by our fellow anthropologists. Under these circumstances the problem of social responsibility was not very pressing. We could manipulate our data, elaborate theories, and speculate to even fantastic limits, without, as we thought, serious consequences. Since the general public was hardly aware of us except as purveyors of bizarre and exotic items about remote peoples on the verge of extinction, the accuracy of our reportage was never questioned. In those days we were not trouble shooters for the government, so that our ideas survived unharmed by use. Nor were we then tempted, even bedeviled, with huge sums to test the power of our peculiar methods to unlock the secrets of why our allies and our enemies behave the way they do. This was, in Edith Wharton's phrase, anthropology's "Age of Innocence." We had, moreover, a curiously ambivalent attitude toward society. We felt emancipated from the forms and restrictions of our own culture, delighting in exposing their irrationality. It did not, for example, seem inconsistent for us to reject the rites and ceremonies of the Christian churches and to have little or no understanding of those who remained faithful to their traditions, and at the same time be able to enter sympathetically into every minutia of a tribal ritual and theorize on its functional necessity in a social organization. I suspect that basically we were playing intellectually with data and lacked any real appreciation that ideas as such can be powerful forces in the world, both for good and for evil. We had neither the responsibility that comes from dealing with ideas in action nor the caution engendered by experimental procedures.

Although at the time we were scarcely conscious of it, we had, nevertheless, been toying with dynamite. As I think back to some of the technical lectures and writings on race professional anthropologists made at that time, I am appalled. Most anthropologists who then and earlier busied themselves with racial problems regarded their activities, I am sure, as interesting but of no major concern to the course of nations or the welfare of millions of people. I am not accusing anthropologists of directly fathering Nazi doctrine, but there can nevertheless be no doubt that anthropological generalizations on race underlay the racist notions that mushroomed in the 1930's. Anthropologists had unwittingly prepared the way for the Huston Stewart Chamberlains, the H. F. K. Gunthers, and the Madison Grants. If these writers were not entirely approved of, neither were their doctrines altogether discarded. After the damage was done and the Frankenstein monster was abroad in the world, anthropologists did their small best to make amends—but it was too late. Only Boas saw early and clearly the horrible consequences of the popular adoption of these racist speculations—innocuous in the academic hall, but murderous in the market place. Before the evil became widely apparent, Boas' reaction was looked on as rather emotional and alarmist. Perhaps because of his European experience, he was extra sensitive to the stirring of a doctrine which meant little to most Americans. I cite this not to attach blame but to illustrate the state of mind that quite generally failed to grasp the possible consequences of current anthropological ideas in terms of social and political action.

The picture I have drawn of anthropology a generation ago has changed profoundly. Now, anthropology, if not at the head of the table, has at least a place not too far from the salt. This enlarged academic prestige can in part be measured both by the extraordinary growth of the older departments and the great increase in newer ones that are springing up all over the land. Within the generation I am describing the membership of the American Anthropological Association has increased about sixfold and the number of professionals in it from about 82 to nearly 500. If the professional standards were as liberal now as they were when I joined as a college senior our fellowship might well number a thousand.

But more significant than numbers is the quality of interest that anthropology is now able to arouse both in the general public and among professional students in other disciplines. I think the anthropologist can be permitted a pardonable satisfaction in the change of status that has lifted him from a position uncomfortably close to that of a poor relation to the more respectable place of someone with at least expectations. His stock in trade has at last begun to have value for the sociologist, the psychologist, the psychiatrist, the philosopher, and various other students of human activities.

This recent growth is only partially the result of the efforts of the anthropologists themselves. The past generation has seen a phenomenal growth in graduate study throughout the United States, resulting from the steady elevation of the national average in attained schooling. Enrollments in colleges and universities have increased far beyond the normal expectation in an increasing population. Along with other sections of the educational system, the graduate school has also flourished. And the voice of the Ph.D., like the turtle's, is now heard in our land.

Anthropology, it must be admitted, owes some of its growth to this general expansion of the graduate field, but not all of it by any means. As one of the social sciences, it is also enjoying a share of the attention that a troubled world is directing toward these sciences. Faced with catastrophic dangers, sharpened by the technological advances of modern times, government, institutions, foundations, and thoughtful individuals are being forced to acknowledge that the role of the social sciences must be made a determinative one if our world is to survive. Unquestionably the pressure of events has thus created a more receptive attitude toward these fields of study and has disposed those who dispense research money and academic preferment to look more favorably on anthropological ventures than they did in the past.

Anthropology, however, has not been supinely carried on the crest of a wave of expanding graduate study. Nor, to change the figure, has it effortlessly ridden the coattails of the social sciences. Some of the credit for the present position is due to its own accomplishments and to the promise it holds for still greater achievements.

In retrospect, then, we see a combination of favorable circumstances conspiring in the past generation to advance the intellectual prestige and the academic status of anthropology. These are:

(1) The general demand for an increased standard of education, which has been a progressive one for a long time but which has recently taken on a marked acceleration and has carried unprecedented numbers to the graduate schools.

(2) The widespread concern of people over the state of the world, and their growing conviction that social sciences may solve the problems created by technological developments in physics and chemistry. One can, I think, also detect a rising segment of opinion that looks to a religious revival and a moral regeneration as the way to save mankind. Nevertheless, the characteristic faith of our age in science has sharpened interest in the social sciences and has turned support to this relatively neglected field. The last report of the Carnegie Foundation points out that currently 73% of the funds voted for this year went to the social sciences. It is also significant that these grants were overwhelmingly concerned with projects "designed to bridge the gap between the universities and the world of affairs." In his report for 1947, Raymond Fosdick, president of the Rockefeller Foundation, lists a greater contribution to the social sciences than to any other of the fields in which the Rockefeller Foundation is interested. This is the culmination of a trend in that foundation's giving and reflects Mr. Fosdick's repeatedly expressed concern for the necessary development of the social sciences in the world of today. The same conviction finds expression in Mr. Conant's reports on Harvard developments.

(3) The success of anthropology in establishing the concept of culture and a methodology for dealing with it; but more particularly the timeliness of this

concept and methodology in respect to developments in other social sciences. Establishment of the cultural concept has had important consequences. It has on the one hand furnished social scientists and philosophers with a corpus of knowledge of great significance to them, thereby consolidating the value of anthropological investigation. And on the other hand anthropology has been encouraged by the nature of its problems to assume both a synthesizing role, in which various other sciences are drawn upon for methods and insights, and a cross-disciplinary function, in exploring the ramifications of the cultural concepts it elaborates. An example of its cross-disciplinary function is the wide interest in personality and culture which has grown out of the more and more refined study of cultural dynamics and which requires for its pursuit the collaboration of the various psychological sciences. Such a collaboration would have been impossible 30 years ago.

Armed with methods and insights derived from a century of investigation among primitive people, anthropology has only in this generation acquired the confidence to project itself into the complexities of modern civilizations. How much of this development was the inevitable evolution of our science it is difficult to say. There are some who still regret this trend and insist that classical ethnology should be confined to the study of primitive peoples and should remain our primary interest. I recall among my contemporaries in my own student days, however, an impatience with the conventional problems that seemed remote from the realities of our world and an eagerness to try our anthropological teeth on the richer fare of our own society. Perhaps this was a reflection of a *zeitgeist,* or the effect of inspired teaching or a response to the stimuli in the productions of cognate subjects. It would be interesting to know how far this eagerness was especially characteristic of American anthropology. In any event, it has led anthropology in this country to the very centers of our social conflicts and to the sources of national as well as individual behavior. Since we have insisted on having our say in these matters and on offering suggestions toward the solution of social problems, we must inevitably expect to shoulder the open responsibility that goes with this office. For whether we like it or not, we cannot escape the consequences of the role we are adopting. As professors of a science outgrowing its short pants (perhaps prematurely, as is the present fashion for boys) we have, I believe, a duty to assume a maturity consistent with anthropology's development. The days when we might act as if our theories were of little consequence to others are gone. For even if we retreat to the refuge of a pure science concerned only with abstractions and general principles, we should have learned from our recent past that some responsibility is inherent in our activities. I do not mean to imply that we either claim infallibility or that the public accords anthropological dicta an unprecedented prestige. We are still received with varying degrees of hospitality but more than ever we are listened to and what we enunciate as anthropological truth is carried far and wide.

Those of us who have seen this change in the fortunes of anthropology are also those whose recollections go back to the Wall Street bubble and the Florida boom, and we might be pardoned in the light of that experience for being at least mildly troubled about anything that looks like a boom. In our lexicon bust follows boom, and burst comes after bubble. I do not, however, speak as a prophet of gloom, for I happen to think that anthropology's future is bright if—and that "if" is what concerns me now.

As I have tried to point out, anthropology has at last arrived at a position where perhaps for the first time, at least in this country, its voice carries some weight both in academic circles and with the public at large. Its prestige within academic circles, of course, is of the utmost importance in providing careers, in the training of personnel and in the institutional sponsorship without which anthropological work might virtually cease. The concrete professional consequence may be seen in the rapidly growing number of anthropological departments in American universities—from a handful a generation ago to 90 recognized departments, by Erminie Voegelin's count, and to between 200 and 300 where anthropology is represented in curricular offerings. To maintain this development and to expand it further, anthropology must retain the confidence of its academic colleagues in the soundness of its research goals and methods.

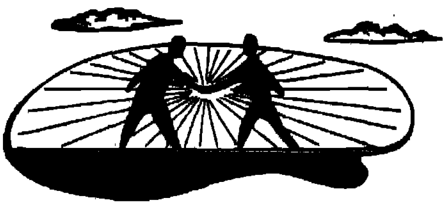
Its standing with the public at large is equally necessary in preserving its academic status and particularly in attracting the intellectual and financial support that we require in our system. But more than this, our authority in the mind of the public carries with it a social responsibility. If what we give out as anthropological dogma is received as tested truth and eventually influences public attitudes, we cannot divest ourselves of the responsibility of our pronouncements. *Caveat emptor* is not a good rule in science. If by our disregard for this fundamental charge we encourage the public to beware of our offerings, we shall soon lack both a public and a science.

If I have overdrawn the picture, it is, nevertheless, valid. Far too often the anthropologist fails to make explicit to the people what may be sufficiently clear to the profession, namely that some of his generalizations are far from being the final blueprint they appear to be. It may or may not make much difference in dealing with fossil man, but there can be little doubt that it makes a vast difference when current social attitudes are involved. This, of course, is a problem in the public relations of all the social sciences and most, if not all of them have been guilty of this failure to distinguish the varying degrees of certainty or probability that characterize the theoretical structures they release to the public. No doubt competitive struggle for attention for one's ideas may motivate the form in which they are presented, and unquestionably many of us in our zeal may speak with honest if unwarranted conviction; but this does not excuse anthropology or anthropologists from the consequences of what we permit to stand as anthropological gospel.

I am not, by this statement of the position of the social sciences in general and of anthropology in particular, implying that what is needed is a board of censorship to protect the fame of these sciences from their own protagonists. Nothing could be more disastrous. Fortunately there is a simpler and healthier mechanism for achieving the kind of clarification for which I am appealing. This is in the development of a rigorously critical attitude toward the speculations and developments embodied in anthropological writing. This is all the more essential since anthropology, as well as the other social sciences, lacks the experimental procedures that exert a profoundly salutary control on the growth of the experimental sciences. Among them, a claim can be immediately checked under similar controls in hundreds of laboratories. And every serious claim is indeed subjected to the rigors of such justification before it becomes acceptable as part of the tested corpus of the discipline. On the contrary, our investigations do not lend themselves readily to this kind of testing. In fact even repeat studies in the anthropological literature are quite exceptional. It is for this reason that I regard it as essential for the continued health of anthropology that we be severely critical in appraising the theories and investigations that are issued as representative of anthropology and which come within our competence. There is, of course, no lack of critical rigor in assessing work that falls into conventional patterns, for which standards and well-tried precedents of reliability are available. And certainly the older theories have with time been subjected eventually to a variety of critical appraisals. But one also notices an amazing failure to examine the fundamental assumptions and premises of new lines of investigation which, like a new fashion in women's wear, appear to exercise a kind of tyranny that no one dares question.

I do suggest that such critiques are desirable and I do know that a number of anthropologists do not hesitate privately or in their classrooms to offer critical comments—yet they are strangely silent in print. If we maintain such a silence, others can only assume that these developments are without blemish and unequivocally represent the best that we can produce. For a long time American anthropologists used to be accused of lacking a facility in theory and of being excessively conservative. I think that charge must certainly be withdrawn now. And I for one am glad to see the new interest in exploring possibilities of the anthropological approach. But anthropology can become healthy and remain so only in the presence of a strongly skeptical and critical spirit which, to be satisfied, requires the best.

[Presidential Address, delivered at the 47th Annual Meeting of The American Anthropological Association in Toronto, December, 1948.]



The Use of Autoradiographs in the Quantitative Determination of Radiation Dosages from Ca^{45} in Bone[1]

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BEFORE IT IS SAFE to introduce radioactive tracers into the human body, it is essential to know that the concentration will at no point become great enough to be a health hazard. The present safe dosage rate limit accepted by the Atomic Energy Commission is 0.1 rem (roentgen equivalent man) per day, or 0.1 rep (roentgen equivalent physical) per day for β-rays (quoted in *Nucleonics*, 1947, 1, 4). The problem of determining local radiation dosages rates is therefore of vital importance in the use of many isotopes. Conventional counter measurements of activity are practically useless in this application, because they give information regarding average dosage rates over a large area, a value which can be several times smaller than the local dosage rates. Therefore, an autoradiographic technique capable of quantitatively measuring local dosage rates in tissue has been developed and is described below. It is currently being applied to the study of radioactive Ca^{45} dosages in bone.

The method consists of making an autoradiograph of the tissue being studied, producing on the same film calibration exposures from radioactive sources of known activity, developing the tissue and calibration exposures simultaneously, and comparing their blackening microphotometrically.

The technique is similar to that described by Axelrod and Hamilton (*1*) for the radioactive sulfur and arsenic studies of mustard gas and lewisite concentration in the skin and eye tissues. However, local radiation dosage is capable of being measured more simply than local isotope concentration.

Concentration deals with the distribution of the radioactive atoms; dosage deals with the distribution of the ionizing radiation from those atoms. Since in concentration studies the atoms are detected by means of their radiations, precautions must be taken to detect each β-ray or photon near its origin; i.e., the tissue section must be thin (microtome-sliced) and the distance between the film and tissue must be minimal. Because of self-absorption and backscattering effects (*5*) it is difficult to compare in a quantitative manner the intensity of radiation from a thick source with that from a thin source. Therefore in concentration studies the calibration source should be of the same thickness as the tissue section—a requirement not always easy to meet in the laboratory.

Dosage measurements, with which this paper is concerned, require tissue sections of dimensions greater than the maximum range of the radiation particles in order that all the radioactive atoms within the range contribute their share of dosage (and therefore film blackening) at the point in question. To be precisely correct, the tissue section should also be large as compared with the mean free path of any accompanying γ-rays, but for practical purposes this would generally be unnecessary. If the volumes of localization are small, and if local concentrations are high (compared with average concentration), the high specific ionization particles produce almost all of the localized dosage, the low specific ionization γ-rays almost none. Since the dosage rate within an infinite, homogeneous source can be readily calculated by the formula given below, such a calibration source, easily prepared, is desirable in dosage studies.[3] The penetration of the radiation is partly dependent on the atomic number of the surrounding elements; therefore it is important that the calibration source be composed of material whose atomic number distribution is the same as that of the tissue. It is obvious that the isotope in the tissue and in the calibration source should be the same.

The dosage *within* this infinitely thick source can be calculated by the formula (*3*):

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[1] Assisted by the joint program of the Office of Naval Research and the Atomic Energy Commission, by a grant-in-aid from the National Institutes of Health, and by a grant from Ciba Pharmaceutical, Inc. One of the authors (R.A.D.) has carried on part of this investigation under a National Cancer Institute Predoctorate Research Fellowship.

[2] The authors wish to thank Dr. Robley D. Evans of the Massachusetts Institute of Technology for his suggestions and guidance in this study.

[3] Certain errors result from the fact that film blackening is not a function of reps of irradiation alone.

$$R = 60\ CE$$

where R = reps/day

C = μc/gm tissue

E = average energy of particles (approximately one-third their maximum energy) in Mev.

This dosage rate (R) within a thick source is our primary consideration. It is approximately twice the dosage rate at the surface, for when a block of material containing a radioactive substance is cut in half, the intensity of the radiation at a point on the cut surface is only one-half the intensity of radiation at this same point before the cut was made. This principle applies to the interpretation of autoradiographs made from tissue as well as calibration sources.

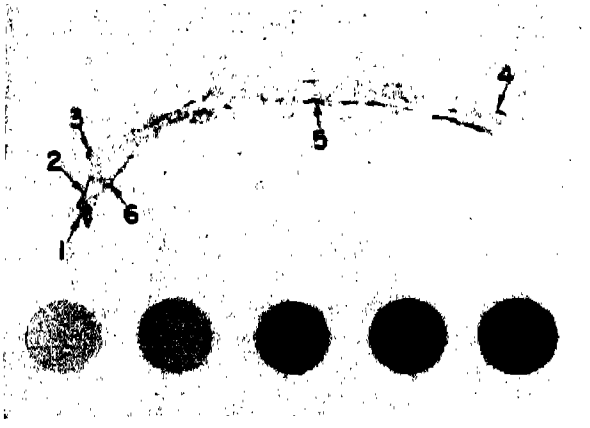

FIG 1. Autoradiograph of dog rib resected 21 days after oral administration of radioactive Ca^{45}. The circles of graded blackening are calibration exposures increasing in magnitude by factors of 2, produced from plaster of Paris blocks containing known amounts of Ca^{45}.

The film characteristic most essential for accuracy is the contrast. Resolution is not of prime importance, since the scattering of the radiation in the thick source affects the film over a diameter comparable with the maximum particle range. Eastman No-Screen X-Ray Film was found to be a relatively good film to register the 0.26-Mev β-rays of Ca^{45} because of its high contrast and sensitivity. However, its resolution is rather low for the purpose, even though high resolution is not essential. It is also desirable to choose a film on which a given number of reps produce the same degree of blackening, regardless of the energy of the β-rays concerned. For energies less than 40 to 60 kev this requirement is not satisfactorily met by films now obtainable (*2*). This consideration is now being further investigated.

After the preparation of the tissue and calibration source, the procedure has been to make the autoradiograph and a set of five calibration exposures (each greater than the preceding by a factor of two) covering the range of exposures in which the film contrast is highest.[4] The blackening of the tissue autoradiograph is then microphotometrically compared with the blackening of the calibration spots, and the local radiation dosage rates in the tissue are thereby determined.

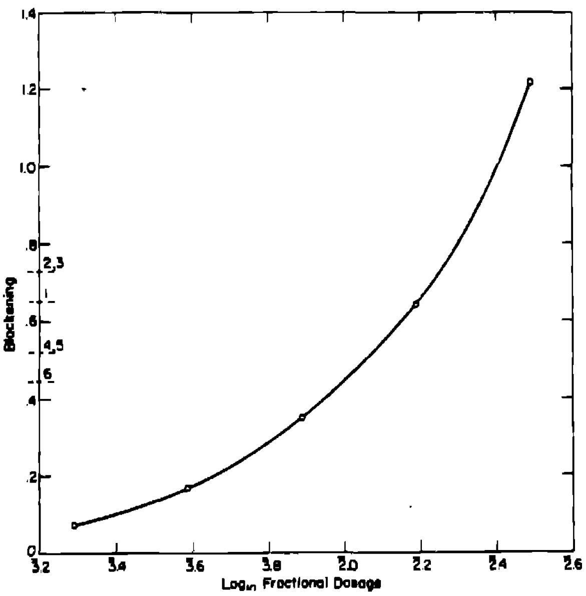

FIG. 2. Microphotometer record of calibration exposures and autoradiograph sites shown in Fig. 1. The points defining the curve are taken from the calibration exposures, and the dashed lines on the vertical scale indicate the blackening of the correspondingly numbered bone sites in Fig. 1. The activity of the calibration sources has been related to that of the dog's blood in such a way that the abscissa, essentially representing log (exposure), can be expressed in terms of log (fractional dosage).

An example of the work currently being done is shown in Figs. 1 and 2.[5] The study was made to determine the amount of dilution of radioactive Ca^{45} by normal calcium while passing from the blood to the bones of a growing dog. Fig. 1 shows the autoradiograph of a rib resected 21 days after the oral administration of the radioactive calcium, and five calibration exposures from artificial sources containing a known percentage of the peak blood activity. Fig. 2 shows the microphotometer record of the

(*Continued on page 348.*)

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[4] Contrast is defined as the slope of blackening (also called density) vs. the log of the exposure. Blackening is defined as $\log \frac{I_0}{I}$, where I_0 and I are the intensity of the light transmitted through the clear film and the spot in question, respectively. Since to a good approximation, the microphotometer deflection $M \propto I$, the contrast is, closely, the slope of $\log \frac{M_0}{M}$ vs. log exposure.

[5] Complete biological results will be published later.

TECHNICAL PAPERS

Absorption of Radioactive Calcium by the Peanut Fruit[1]

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Nutritional studies of the peanut plant, *Arachis hypogaea* L., indicate the necessity of an external supply of available calcium in the fruiting zone for normal fructification (*2*, *3*, *6*). The relation of the calcium supply to fruit development is the type of problem particularly suited to radioactive tracer study. The availability of calcium 45 facilitates the investigation of this fundamentally and economically important problem.

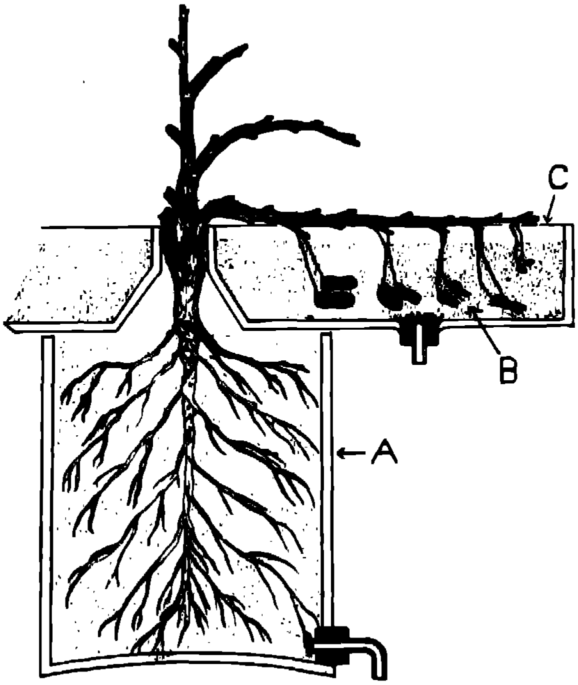

FIG. 1. Diagrammatic view of the peanut plant showing: A, rooting medium; B, fruiting medium; and C, wire mesh support to prevent branches and foliage from touching sand of the fruiting medium.

The runner-type peanut has a prostrate growth habit and bears its fruit from nodes along the trailing branches. Thus it is possible to separate completely the rooting medium from the fruiting medium of the plant. Peanut plants of the Dixie Runner variety were grown in sand culture with the root and fruit zones isolated from each other as shown in Fig. 1. The roots of 2 plants were in 4-gal glazed crocks and the sand of the fruiting zone was held in asphaltum-coated metal pans. A complete nutrient solution (*1*) was applied to the surface of both zones of the plants. When necessary, solution drainage from each zone of the plants was caught in 5-gal carboys. At 110 days plants were vegetatively vigorous and all stages of immature fruit development were present. At that time a single application of labeled calcium, as a solution of the chloride containing approximately 1.36 mg of calcium with an activity of 21 mc, was added to 1 l of nutrient solution and applied to the rooting or fruiting medium of each culture of 2 plants. Thereafter, drainage of any solution was returned to the proper receptacle. The fruiting zone treatment was discontinued after 9 days but the treatment of

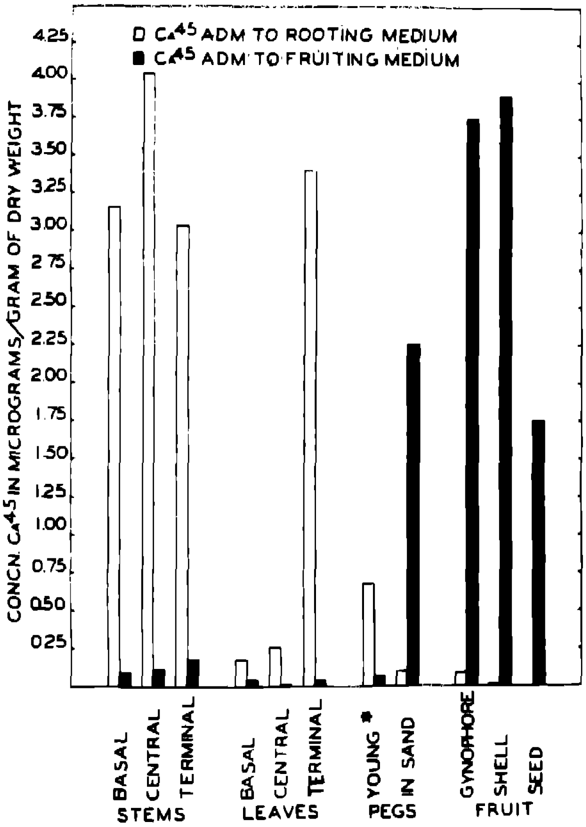

FIG. 2. Concentration of Ca^{45} in various portions of peanut plants 9 days after it was administered to the rooting or fruiting medium. The asterisk indicates young pegs (1" – 1½" long) which had not touched sand of fruiting medium.

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[1] Published with the permission of the director of the Florida Agricultural Experiment Station. The Ca^{45} was obtained from the Oak Ridge National Laboratory on allocation from the U. S. Atomic Energy Commission.

the root cultures was continued for 24 days. There were 4 replicates or a total of 8 plants to each treatment, and each plant, whether treated on the rooting or fruiting zone, was exposed to the same dosage of labeled calcium.

Leaves and sections of stems and fruiting organs of plants were sampled at periods of 3, 8, and 50 hr, and 9 and 24 days. Samples of leaves and stems were from lateral branches, since the peanut plant has a short upright central stem. Gynophores and fruits were thoroughly washed with a stream of distilled water when harvested. Samples were immediately weighed and subsequently dried at 70° C. The plant material was ashed and the calcium precipitated as the oxalate (*7*), which was collected on filter paper over a uniform area for measurement of total calcium by weight and radioactivity with a thin mica window Geiger counter (*5*). Self-absorption and decay corrections were made in the usual manner (*4*).

The pattern of labeled calcium distribution was similar for all plants of a given treatment. Fig. 2 illustrates the uptake of Ca^{45} in μg/gm of dry weight of portions of two representative plants after 9 days. Plants received the complete nutrient solution on the rooting and fruiting zones, and experimental conditions other than the zone of labeled calcium supply were the same in both cases.

Ca^{45} administered to the roots could be detected after 3 hr in all vegetative portions of the plant, being most pronounced in the stem, but was found only in the young peg (gynophore and ovary) of the different fruiting stages. The young peg consistently showed a more active absorption of calcium than the other classes of fruit; however, the capacity for calcium absorption decreased as the peg elongated and entered the fruiting medium. At 9 days the shell of fully developed green fruit contained a very small amount of labeled calcium, but never more than a trace could be detected in the seed. This relationship persisted throughout the 24 days.

The uptake of labeled calcium by the developing fruit was reversed when it was administered to the fruiting zone. The very active absorption of Ca^{45} by the gynophores and by shells and seeds of the fruit from the external supply in the fruiting medium very greatly exceeded the small amount of absorption by these organs when labeled Ca was supplied to the rooting zone of the plant. This emphasized the capacity for calcium absorption by the developing fruit from the external supply in the fruiting medium.

It is noteworthy that when labeled calcium was applied to the roots of the plant, the capacity for calcium absorption by the young peg decreased as it developed as shown by the decreased absorption of labeled calcium. Thus it appears that the calcium content of the young peg was diluted as it increased in size and that most of the Ca^{45} found in the fruit was absorbed in the early stages of peg development. This suggests that the capacity for calcium absorption by the gynophore and ovary is limited after a definite point during their development and that further fruit development is apparently dependent upon the external supply of calcium in the fruiting zone.

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The Influence of Delta and Gamma Benzene Hexachloride upon the Oxygen Uptake of Brain[1]

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During a study of the pharmacology of some stereoisomers of benzene hexachloride (BHC) in mammals, it was observed that whereas the gamma isomer is a potent convulsant agent, the delta isomer is a central nervous system depressant. Moreover, it was found that the two isomers are mutually antagonistic in their effects upon the central nervous system of the rabbit and dog (*5, 6*). In the same studies attempts were made to mitigate the effects of the gamma isomer by the administration of *i*-inositol, which was reported by others to prevent the growth-inhibiting action of the gamma isomer upon certain strains of saccharomyces (*4*). In no instance did *i*-inositol modify the course of convulsant action of γ-BHC. It was believed possible that this failure might be due to lack of penetration of *i*-inositol into susceptible brain cells. In view of these observations, and the often mentioned correlation (*1–3, 7–9*) between narcosis and brain oxygen uptake, the following study was initiated.

In exploratory studies rats received intraperitoneally sufficient drug to produce central stimulation (100 mg/kg of γ-BHC) or central depression (500 mgm/kgm of the delta isomer). The rats were decapitated after the onset of symptoms, and the QO_2 of brain slices was determined manometrically. By this method no difference could be observed between control and test brain slices. For the experiments reported herein, the following technique was employed: Normal rats were killed by decapitation, and the brains were removed and weighed. The entire brain was then placed in a homogenizer tube and 0.05 cc of a 10% solution of the drug in peanut oil per gram of brain was added. Pure oil was added to controls. The brain and the oil solutions were then homogenized. Sufficient quantity of a modified Krebs phosphate solution (containing 0.1% glucose) was added to make the final homogenate, containing 125 mg brain (wet weight) in 3 cc. This technique was necessitated by the low water solubility of the BHC isomers. The homogenate was equilibrated with room air at 38° C for 10 min and allowed an additional equilibration period of 10 min after the vessels were closed. Readings were taken at 15-min intervals for a period of 1 hr.

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[1] *In previous reports the authors used the word* "Gammexane" as a synonym for the gamma isomer of benzene hexachloride. It has been brought to our attention that the name "Gammexane" is a trade mark designation of the Imperial Chemical Industries, Ltd. The term gamma benzene hexachloride has been approved by the Committee on Insecticide Nomenclature of the American Association of Economic Entomologists (*J. econ. Entomol.*, 1947, **40**, 280).

[2] The technical assistance of Anne M. Kunkel and Dorothy E. Stabile is gratefully acknowledged.

TABLE 1

EFFECT OF ISOMERS OF BENZENE HEXACHLORIDE ON BRAIN OXYGEN UPTAKE

Compound	Brain (mg/gm)	No. of determinations	QO_2 (wet wt)	Ratio experimental/control
Control	....	9	0.79 ± 0.1*	1.00
Alpha	2.5	6	0.92 ± 0.07	1.16
	5.0	6	0.97 ± 0.07	1.23
Gamma	5.0	11	0.76 ± 0.06	0.96
Delta	0.5	4	0.93 ± 0.10	1.18
	1.25	5	1.13 ± 0.09	1.43
	2.5	5	1.23 ± 0.13	1.56
	3.75	5	1.46 ± 0.07	1.85
	5.0	11	1.40 ± 0.16	1.77
Delta	5.0	4	1.41 ± 0.19	1.78
+				
Gamma	5.0			
Delta	5.0	1	1.35	1.71
+				
Inositol	25.0			
Gamma	5.0	1	0.77	0.97
+				
Inositol	25.0			

* $\sqrt{\frac{\Sigma d^2}{N}}$

The QO_2 values obtained on rat brain homogenates containing added drugs are shown in Table 1. Whereas γ-BHC failed to alter the oxygen uptake of the brain, the delta isomer significantly increased this function. Inositol did not alter the oxygen uptake produced by either isomer and γ-BHC exhibited no antagonism against the effects of the delta isomer.

The most striking fact obtained from this study was the unexpected position of the two isomers with respect to their effects upon the brain-homogenate respiration. The narcotic isomer (delta) produced as high as an 80% increase in respiration over the control. Moreover, its pharmacological antagonist, the gamma isomer, a powerful convulsant, did not modify this effect. In addition, i-inositol was similarly without effect. The "stimulating effect" of the delta isomer upon the respiration of brain homogenate in the face of its narcotic properties *in vivo* is not yet understood and requires further study. The possibility that this increased oxygen consumption is merely a reflection of the oxidation of the halogenated hydrocarbon cannot be overlooked. However, it is interesting to consider these facts in light of the previously mentioned hypothesis of the mechanism of action of certain narcotic agents.

The unaltered QO_2 values observed in the exploratory studies on rats poisoned prior to decapitation is also noteworthy. Similar results have often been observed for other anesthetics which depress the oxygen uptake of the brain on direct addition *in vitro*. Quastel (7) explains this by an outward diffusion of the drug from the cells to the medium. It does not seem likely that this explanation would hold in the case of the isomers of BHC since these compounds are oil rather than water soluble. No explanation for this divergence can be offered at this time.

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Color Change of Strawberry Anthocyanin with D-Glucose[1]

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Strawberries (garden varieties) are usually prepared by mixing with granulated sucrose prior to freezing. Due to the scarcity of this sugar during the war years, experiments to substitute other sweetening agents were initiated. When crystalline glucose was used a violet-to-blue coloration developed on freezing, which reverted to the original red color on thawing. This color change with glucose may be peculiar to strawberries, since it has not been observed with small fruits such as red raspberries. Interest in the applied as well as in the fundamental aspects of this phenomenon led us to an investigation.

Customarily, sliced strawberries are frozen with sucrose in a ratio of four parts of fruit to one part of sugar. In this preparation no change in color occurs. However, thirty varieties of strawberries grown in Geneva all turned violet when frozen with ordinary commercial crystalline glucose at −23.3° C. in a four to one ratio. Differences in the time required to produce the color change were observed. Ten samples of the same variety (Dresden) showed color variations of essentially the same order of magnitude as those obtained with the different varieties. The only exception was a recently named strawberry, Fairland, which showed violet color only after 27 days' storage. Common varieties like Marshall, Blakemore, Dresden, Howard 17 and Culver all turned violet in one to five days. The minimum amount of glucose required to produce the violet color in the strawberries was found to depend largely on the presence of undissolved glucose. Violet color formation was observed only in those samples which contained glucose in a solid form. It is significant to note that all the violet material was always found associated with the undissolved glucose and that in those places where there was no solid glucose the strawberry preparation stayed red. Whether the glucose crystallized during storage or whether it was originally present as a solid did not seem to affect the color change. Another observation was that the time of separation of the glucose often does not coincide with the first appearance of the violet color.

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[1] Approved by the Director of the New York State Agricultural Experiment Station October 18, 1948 for publication as Journal Paper No. 778.

As was expected, the anthocyanin pigment of strawberries plays a dominant role in the violet color development. When the anthocyanin chloride (*1*) (believed to be mainly pelargonidin 3-monoglucoside) is dissolved in Sorensen's sodium citrate-hydrochloric acid buffer of pH 3.4, or distilled water, and the solution is saturated with chemically pure D-glucose, and frozen at – 23.3° C, a violet color is obtained. If similar solutions are allowed to evaporate at room temperature, the anthocyanin also turns violet. This residue is stable at room temperatures. The anthocyanin reverts to the red form when the frozen samples are thawed or when distilled water is added to the dry material.

These tests led to the conclusions that (1) the violet color is not due to possible impurities of the glucose used since c.p. D-glucose gives identical results; (2) low temperatures are not necessary for the formation of the violet color; and (3) the color change is reversible. The rate of color formation is influenced by the pigment concentration. Solutions containing 25% glucose showed violet spots after 10 days' storage at – 23.3° C only if the anthocyanin concentration was 12 mg% or higher. The role of pH seems to be of minor importance. When the pH of frozen samples is lowered to pH 3.0, 2.5 and 1.8 a retarding affect with increasing acidity is noted. The air-dried, violet anthocyanin-glucose mixture turns red on heating. The transition temperature, which is not very sharp, is between 65° and 70° C for the pulverized material. Whether or not a loss of water occurred during the heating period was not determined.

Although a number of sugars were tested, only glucose gave a characteristic color change with the anthocyanin. Tests with sucrose, galactose, rhamnose, fructose, maltose, and α methyl glucoside were negative. Several of these sugars did not separate from solution under the conditions of the experiment and this may have caused the negative results. Inconclusive results were obtained with invert sugar. Arabinose seems to have a very slight effect.

Should it be found that the described reaction really is specific for pelargonidin 3-monoglucoside (or other glycosides of pelargonidin) it could well serve as a qualitative test for these compounds.

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The Effect of Pteroylglutamic Acid on the Aromatic Amino Acid Metabolism of Premature Infants[1]

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Scorbutic guinea pigs fed tyrosine (*4*) and prematurely born infants fed cow's milk mixtures of relatively high protein content (*3*) excrete large amounts of hydroxyphenyl derivatives in the urine. These can be decreased markedly by the administration of ascorbic acid (*3, 4*). Woodruff and Darby (*5*) studied the effect of administration of PGA on the excretion of hydroxyphenyl derivatives by scorbutic guinea pigs and found that PGA repaired the defect produced by lack of ascorbic acid. Johnson and Dana (*2*) have reported that ascorbic acid produced significant increases in weight gain and leucocyte and normoblast count in PGA-deficient rats.

TABLE 1

EFFECT OF ORAL PGA ON "TYROSYL" EXCRETION

Infant B. L.—weight at birth: 2.15 kg

Age in days	Weight in kg	Urine "tyrosyl"	
		mg/cc	mg/kg/24 hr
14	2.04	1.5	40
16	2.05	1.1	34
21	2.47	.4	18
29	3.98	5.2	280
30	2.95	5.4	357
31	PGA—5 mg started daily by gavage		
34	2.95	4.8	368
37	3.09	4.3	279
41	3.10	3.4	234
42	PGA—10 mg started daily by gavage		
44	3.26	3.1	267
46	3.40	1.4	112
50	3.52	0.2	17

In the present study, PGA was given to 10 premature infants fed cow's milk mixtures containing 6 g of protein and 120 cal per kg of body weight per day, but no ascorbic acid. Urine was collected for timed periods of approximately 24 hr and hydroxyphenyl derivatives were determined (*1*).

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[1] Aided by grants from the Mead Johnson Company, Evansville, Indiana, and Continuing Research Fund of the University of Colorado Medical Center.

[2] Postdoctoral Fellow of the United States Public Health Service.

All ten infants excreted significant amounts of "tyrosyl" before administration of PGA. For one infant, A.L., the gavage feeding of 5 mg of PGA daily for seven days produced a striking decrease in "tyrosyl" excretion, which persisted as long as 13 days following cessation of PGA therapy. For his twin brother, B.L., gavage administration of 5 mg daily for 10 days was without effect, but 10 mg was effective after four days, (see Table 1). For infant P., the gavage feeding of 30 mg of PGA for eight days was ineffective, but the intramuscular injection of the same dose for two days led to a prompt drop in hydroxyphenyl excretion (see Table 2). For infant R., the administration of folic acid, 10 mg orally for 16 days, had a partial effect, but the administration of 30 mg intramuscularly for three days produced a striking effect. For the remaining six infants, PGA was ineffective whether given orally or by gavage in daily doses of 10–30 mg for periods of 8–15 days, or intramuscularly in daily doses of 15–30 mg for periods of 5–8 days. In five of the six infants for whom PGA was ineffective and who were given ascorbic acid, there was a prompt decrease in excretion of hydroxyphenyl derivatives. The findings for one infant in this group are given in Table 3.

TABLE 2

EFFECT OF INTRAMUSCULAR PGA ON "TYROSOL" EXCRETION

Infant P—weight at birth: 0.97 kg

Age in days	Weight in kg	Urine "tyrosyl"	
		mg/cc	mg/kg/24 hr
48	2.01	3.4	224
52	2.24	3.2	187
53	PGA—30 mg started daily by gavage		
57	2.27	4.4	227
61	2.35	3.2	273
61	PGA discontinued		
65	2.50	4.8	281
69	2.55	5.1	286
74	2.78	4.1	310
76	PGA—30 mg started daily by intramuscular injection		
78	2.92	0.2	10.0

TABLE 3

LACK OF EFFECT OF PGA ON "TYROSOL" EXCRETION

Infant B. P.—weight at birth: 2.19 kg

Age in days	Weight in kg	Urine "tyrosyl"	
		mg/cc	mg/kg/24 hr
15	2.13	4.0	240
17	2.27	4.5	337
18	PGA—10 mg started daily by gavage		
20	2.30	3.0	201
23	2.50	4.4	290
27	2.64	4.8	324
31	2.75	5.1	380
32	PGA—20 mg started daily by gavage		
37	2.95	6.1	212
39	3.03	3.9	278
43	3.15	4.6	282
43	PGA—15 mg started daily intramuscularly		
48	3.32	4.4	242
48	PGA discontinued—ascorbic acid 100 mg intramuscularly		
52	3.43	0.4	33

Definition of the conditions under which pteroylglutamic acid is or is not effective in premature infants remains the subject for future studies. It is of interest that a difference dependent on the route of administration was the deciding factor in two of eight infants tested. The variability in response recalls a similar experience with liver extract noted in a previous study (*3*).

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A Method for Self-Control of Population Growth among Mammals Living in the Wild[1]

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It is a common observation that the numbers of most organisms in a reproducing population reach an equilibrium with the conditions of their environment. In approaching this upper limit of the logistic of the population, Pearl (*2*) has pointed out that "the rate of reproduction or fertility is negatively correlated with density of population." This is merely a statement of fact which prompts the study of the mode by which the reduction in contribution of progeny to the population occurs. Whatever the means of reduction, the result is that there are less adults to compete for the existing supply of food and harborage.

A recent note in *Science* by Mirone, *et al.* (*1*) suggests one possible way in which the increment to a population may be effectively reduced. They observed in mice that newborn young of mothers on a poor diet frequently fail to survive past the fourth day. From the fact that these same mothers may successfully rear adopted litters born to mothers on an adequate diet, they conclude that failure of the litters to survive is due to inadequate nutrition during gestation. This conclusion suggests that any environmental conditions which affect the maternal

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[1] The work reported in this paper was conducted under a grant from the International Health Division of the Rockefeller Foundation.

physiology to the extent that foetal nutrition is lowered will slow down the rate of population growth due to early post-parturition mortality.

Recent observations on the growth of a colony of wild Norway rats (*Rattus norvegicus*) indicates that this process of upsetting maternal physiology may be one of the limiting factors in population growth. This experimental colony is maintained in a 100′-square pen where abundant food (Purina fox checkers) is continually available in a 20′-square central pen to which the rats gain access by four narrow passages. Fig. 1 shows details of the pen.

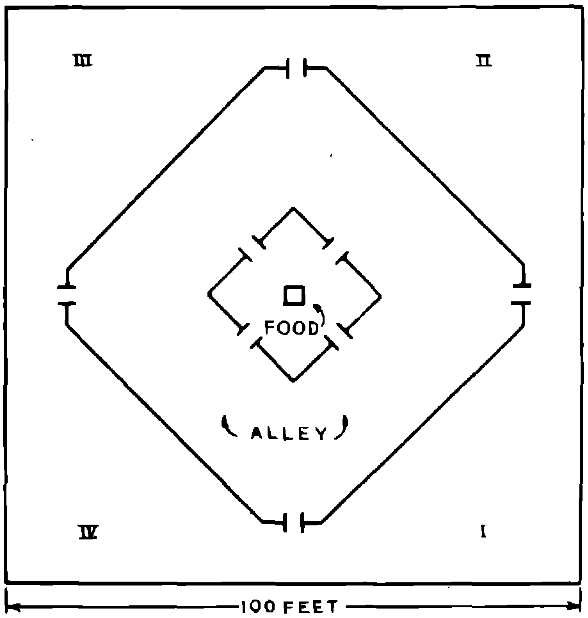

FIG. 1. Diagram of pen in which rats are housed: outer, central, and middle fences which prevent rats from passing over or under them; 8 passages through fences (8″ clay drain tiles); food and water continuously and abundantly available in central pen; 9 harborage boxes in each of the 4 triangular corner areas; rats allowed to dig burrows in alley and in triangular areas.

The colony in the pen was begun with five pairs of rats, which are assumed to have been as genetically homozygous as it is possible to trap them in the wild state. This assumption is made on the following inferential grounds. The rats were trapped in February 1947 on Parsons Island, a 150-acre tract of land in the Chesapeake Bay. Its land bridge with the mainland was severed about 40 years ago, since which time the rats have been effectively isolated. The number of rats on the island has fluctuated widely both on an annual basis and on the basis of changes in agricultural practices. An experimental reduction by poison in 1923 was conducted by the Fish and Wildlife Service. A second experimental reduction was conducted in the spring of 1946 by J. T. Emlen and D. E. Davis, of the Rodent Ecology Project. Estimations of numbers: (a) pre-poisoning, 670; (b) post-poisoning, 220. At the time of trapping in February 1947 surveys indicated that there were probably no more than 150 rats on the island. Under these circumstances of fluctuation in population size, it might be anticipated that considerable homozygosity would have been reached through gene drift (*3*). It is from this inference that the conditions here reported are judged to arise from environmental rather than hereditary differences.

Rats living in the triangular areas were further from the food source than were those living in the alley. There was thus produced a simple gradient of availabilty of food in which one group of rats had an advantage over another group. This gradient of availability of food was intensified by the social life of the rats. Rats become attached to certain areas of the pen and their movements are mainly confined to these areas and from it to the food pen and back. In order to get to the food pen, rats living in the triangular areas frequently must pass near the burrows of rats living in the alley. At such times they may be repulsed by the resident rats. Such repulsion is particularly severe when the resident alley rat is a lactating female. With frequent repulsions the individual's growth rate is slowed down, and since weight is a major factor in winning combats, such individuals occupy a low position in the social hierarchy, and in extreme cases the individual becomes so inhibited that it approaches the food pen with great caution, even when no other rats are about.

TABLE 1

PHYSICAL STATE AND REPRODUCTIVE CONTRIBUTION[*]
(January 1 to September 25, 1948)

		Average wt. (gms)	Average wounds	No. of pregnancies	Litters weaned
Born in an Area Harborage Box	♀ 17	370^7	14^6	3	1?
	♀ 20	388^4	14^4	4[†]	0
	♀ 25	371^7	15^9	5[†]	0
	L - 3 ♀♀	370	14.3	12	1?
Born in Alley Burrow	♀ 33	451^4	1^5	3	2 (3rd?)
	♀ 37	411^4	0.6^5	5	4
	♀ 43	426^5	3^4	4	4
	L 5 ♀♀	420	1.5	12	10

[*] Superscripts denote number of observations from which averages were determined.

[†] Each includes 2 pregnancies for the fall of 1947.

To illustrate the effect of social conditioning on physical well-being and reproduction the histories of three females from each of two litters are given in Table 1. Litter 3 (L-3) was born May 30, 1947, in one of the triangular areas. Litter 5 (L-5) was born August 16, 1947, in the alley near the food pen. Though born 2½ months later the L-5 females average 50 gms heavier than the L-3 females as adults. As individuals, the upper asymptote of their growth curves was reached in 8 months by L-5 females, but not until 12 months by L-3 females, when weight is used as the criterion. The degree of social inhibition is reflected in the number of fresh wounds recorded at each time of handling. It is the loser in a combat which usually receives wounds as it turns to flee. L-3 females received nearly 10 times as many wounds as L-5 females.

It so happened that the total number of pregnancies for the females in each litter to the last date of handling was the same. The contrast between the two groups in their reproductive history lies in the fate of their litters. Although the socially dominant, larger females were known to have weaned 10 litters from their 12 pregnancies, the socially inhibited individuals with a retarded growth rate definitely weaned no more than one litter. These observations give no direct evidence as to the cause of the differential survival rate of the young of these two groups of females. However, the histories of the mothers indicate that there is a physiological and psychological disturbance in socially inhibited individuals which might have a deleterious effect on the progeny either through poor foetal nutrition or from breakdown of maternal instincts. At any rate, social conditioning may be a potent factor in population control among mammals.

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Chemical Analysis of Spectrophotometric Findings in the Cerebrospinal Fluid

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An attempt to interpret the absorption band shown by cerebrospinal fluids (CSF's) at 2,650 A has to take into consideration a number of substances (*4*): barbiturates, ascorbic acid, purine-pyrimidine compounds and also, to a certain extent, proteins, although the latter give a maximum absorption at a somewhat longer wavelength (2,750 A). While it is easy in most cases to exclude barbiturates by avoiding or stopping their administration several days before the spinal tap, it seems desirable to determine by chemical methods the relative participation of the other components responsible for the absorption at 2,650 A. In 40 CSF's of patients with organic or functional nervous disorders, the ultraviolet absorption and the ascorbic acid content were determined simultaneously, the first by means of a Beckman photoelectric spectrophotometer, the latter by the method of Robinson and Stotz (*2*), as recommended by Satterfield (*3*), and using a Klett-Summerson colorimeter. The data resulting from routine examination of the CSF (total protein, globulin, cell count, Wassermann, colloid gold) were available. In cases in which these data and/or a shift of the ultraviolet peak to 2,750 A indicated an increase of proteins, we determined the protein content also, after the spectrophotometric study; the opalescences caused by sulfosalicylic acid both in a known standard solution and in the CSF were compared by means of the Klett-Summerson colorimeter.

With the help of our standardization graphs, the ascorbic acid values were converted into extinction coefficients and these values (Ea) were subtracted from the experimentally determined extinction coefficients of the CSF (Ecsf) so that a difference (D_1), unaccounted for by the ascorbic acid, resulted. Similarly, the protein values were converted into extinction coefficients (Ep), so that finally a residual value (D_2 = Ecsf-Ea-Ep) was obtained.

The material was arbitrarily divided into three groups, one with low D_1 values (0–0.4), one with intermediate D_1 values (0.41–0.8), and one with high D_1 values (above 0.8). In the first group showing D_1 values below 0.4 and D_2 values up to 0.14, apparently the ascorbic acid and protein content of the CSF accounted for the selective absorption with the peak at 2,650 A. These were cases without definite structural alterations of the central nervous system or with preponderant lesion of the white matter, cases studied one or more years after cerebral injury or in the early stage of cerebral affection.

In group II, showing D_1 values between 0.45 and 0.8 and D_2 values up to 0.61, there were cases of herniated discs, cerebral dysrhythmias, head traumata, an encapsulated metastatic carcinoma of the brain, and a hydrocephalus.

In group III, with D_1 values varying between .84 and 2.3 and D_2 values up to 2.16, ruptured discs, producing spinal block, convulsive disorders, concussion studied shortly after the accident, post-traumatic encephalomalacia, compression of the spinal cord, and particularly tumors of the central nervous system were found. It should be emphasized that this enumeration is only descriptive, and that differential diagnostic conclusions will depend on further studies on a larger material.

These findings indicate that the selective absorption of CSF's cannot be explained in all instances by the ascorbic acid and protein content as claimed by some authors (*1*, *7*). In interpreting the residual D_2 values, it seems of interest that they were particularly pronounced in tumors of the central nervous system, i.e., in conditions where a marked destruction of nuclear substances may be expected. It should also be noted that there was a statistically significant difference between the mean E of normal control CSF's and that of CSF's withdrawn between 1 hr and 2 months after cerebral concussion (*6*), and also that D_2 values above the normal range were demonstrable in CSF's tapped shortly after cerebral concussion. These observations are mentioned because this type of cerebral trauma induces chromatolytic changes in the nerve cells (Windle *et al.*, *8*). It therefore seems justified to assume that the residual D_2

values observed are caused chiefly by constituents of nuclear substances such as purine-pyrimidine compounds.[1] These are not necessarily nucleic acids, but may be their cleavage products, as pointed out previously (Spiegel-Adolf *et al.*, *6*).

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Some Effects of Nonherbicidal Concentrations of 2,4-D on the Development of the Bean Plant

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Reports on the influence of nonherbicidal concentrations of 2,4-D on bean plants have been published by Wittwer and Murneek (*8*), Weaver (*7*), Burton (*1*), and Stromme and Hamner (*6*). The results of the preliminary experiment reported here confirm and extend previous observations on the morphological effects of 2,4-D on beans and on the delaying and inhibiting effect of 2,4-D on reproductive development found by Weaver (*7*) and Stromme and Hamner (*6*). No hastening of maturity or increase in yield such as was reported by Wittwer and Murneek (*8*) was found in this study.

Plants of *Phaseolus vulgaris* L. (var. bountiful) were sprayed on both surfaces of all leaves with 1, 5, and 10 ppm of the sodium salt of 2,4-D on February 27, 1948, when they were 21 days old and had two fully expanded compound leaves. Although there were only four replications per treatment because of space limitation, statistical analysis of the data secured indicated the differences reported here to be statistically significant except where otherwise noted. Daily observations of the development of each plant were made, and all abscised leaves were retained for inclusion in the final dry weight determinations. The plants were allowed to complete their life cycles. No pods were removed until they were dry and mature, but they were picked before dehiscence to avoid the loss of seeds. By April 30 all leaves had abscised and all seeds matured. Dry weights were then determined.

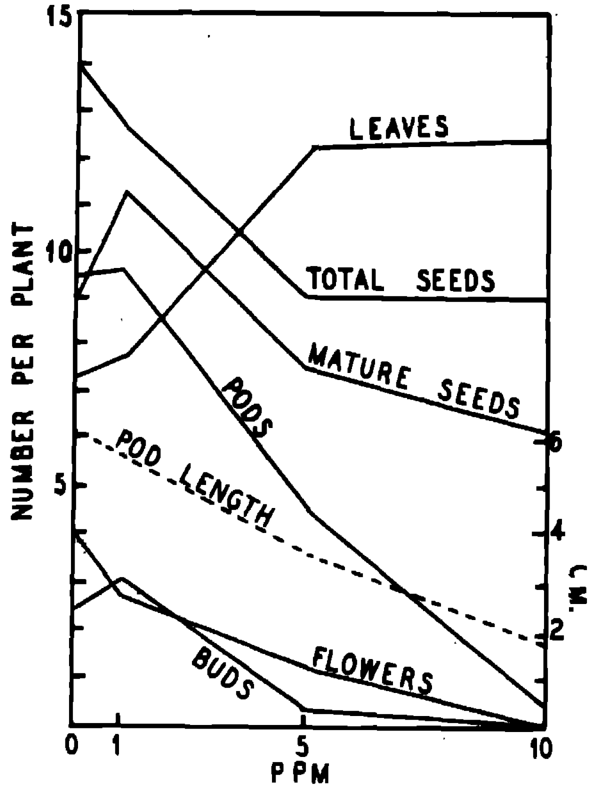

Fig. 1. Mean number of parts per plant and mean length of pods, illustrating the delaying and inhibiting effect of 2,4-D on reproductive development. The data on flowers and flower buds were secured March 10, on pods March 19, and on seeds and leaves April 30.

None of the treatments produced visible effects on the opposite, simple leaves, but the compound leaves of plants sprayed with 5 and 10 ppm exhibited characteristic inward rolling and epinasty. In three plants receiving 10 ppm the stem assumed a horizontal position, and the youngest fully expanded leaf a vertical position. The stem resumed vertical growth at the next node, but the horizontal portion remained in that position. Otherwise, recovery from epinasty had occurred by March 3. The 5- and 10-ppm concentrations caused a temporary inhibition of growth in height, but there were no significant differences in final height. By March 13 all plants sprayed with 5 and 10 ppm and, to a slight degree, some of those sprayed with 1 ppm had developed new leaves with crinkled, lanceolate, and mottled leaflets. The tissue adjacent to the veins became chlorotic, but the leaflet margins and vein islets remained green. By March 19 the leaves of the control plants and some of those on plants which had received 1 ppm were turning yellow, apparently due to the approach of maturity, but all leaves on the plants which received 5 or 10 ppm were still dark green. Small, white, conical outgrowths developed on the

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[1] In this connection, it also seems noteworthy that in some conditions associated with a statistically significant increase of the selective absorption of the CSF at 2,650 A (e.g., following repeated electro-shock treatment), substances able to split *added* nucleic acids are increased in the CSF (*6*).

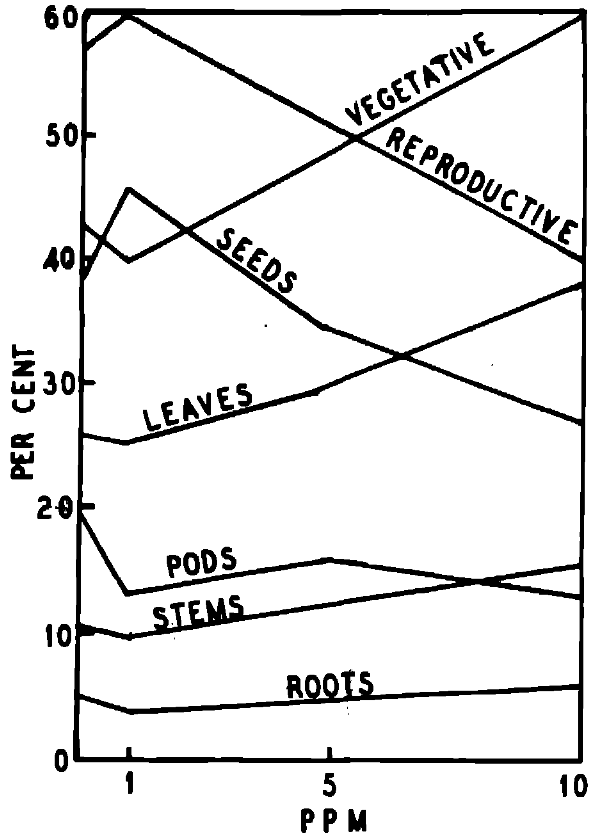

FIG. 2. Effect of 2,4-D on the dry weight of the various organs of bean plants and of the total vegetative and reproductive organs, expressed as percentage of the total dry weight.

under surfaces of some of the most deformed leaves. These were similar to those reported by Felber (*3*) but had developed during March and April, while Felber found such proliferations on the lower epidermis regularly only from June to October.

The 2,4-D appeared to promote, rather than to delay or inhibit, leaf abscission. Leaf abscission began on the controls and plants in all treatments on March 30 but was completed a weak earlier in the plants sprayed with 5 or 10 ppm than on the controls or plants sprayed with 1 ppm. The abscission of leaves from all plants reached a peak between April 11 and 14, and the rate during this peak period was higher for all treated plants than for the controls.

All controls and plants which received 1 ppm, and two plants which received 5 ppm began blooming on March 8, but none of the plants sprayed with 10 ppm bloomed until a week later. The number of macroscopic flower buds and flowers on March 10 is given in Fig. 1, and the data on pods in this figure provide additional evidence of the delaying effects of the 5 and 10 ppm concentrations on reproductive development. That this repression of reproductive development was not due to a general repression of growth is indicated by the increased vegetative development of the treated plants (Figs. 1 and 2). Some of the flowers on the plants sprayed with 10 ppm were deformed, having greatly reduced petals, elongated and exserted styles, and ruptured ovaries. The pods of the plants sprayed with 5 and 10 ppm were unusually dark green, and even those on plants sprayed with 1 ppm were darker green than the controls.

None of the treatments had a significant effect on total dry weight of the plants, but there were significant differences in the dry weights of the various organs (Fig. 2). The 5- and 10-ppm concentrations definitely produced a decrease in the dry weight of the reproductive organs and a concurrent increase in the dry weight of the vegetative organs. The 1-ppm concentration, however, produced a significant effect which was the reverse of this, due principally to the unusually high seed weight in this treatment. This was not due to a greater weight per seed, nor to a larger total number of seeds, but to a larger number of fully mature seeds (Fig. 1). In general, the weight per seed decreased with an increase in concentration. (The mean weight of the mature seeds of the controls was 0.328 gm, and mean weights of the seeds of the plants treated with 1, 5, and 10 ppm were 0.286, 0.337, and 0.259 gm, ± 0.020). There is no evident explanation for the high weight per seed in the 5-ppm treatment. The increase in the total dry weight of the leaves with concentration of 2,4-D was due to the increase in the number of leaves, rather than to an increase in weight per leaflet, which actually decreased with higher concentrations. It seems possible that the delaying and inhibiting effects of 2,4-D on reproductive development reported here and by other investigators are the same type of phenomenon as the inhibition or delay action of other growth substances, reported by Dostal and Hosek (*2*), Obsil (*5*), Galston (*4*), and others.

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The Effect of Castration and of Testosterone upon the Respiration of Rat Brain

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In an earlier paper (*3*) it was reported that various steroids are capable of inhibiting the oxygen uptake of rat brain homogenates. It was found that testosterone inhibits the oxidation of glucose at some point preceding participation of the cytochromes in "the main line of biological oxidation'' (*3*). In an attempt to determine whether or not testosterone is concerned with normal oxidative mechanisms, we have compared the respiration of tissues of castrated rats with the respiration of tissues of normal and testosterone-treated castrated rats.

TABLE 1

	Number of animals	Body weight gm ± σm*	Weight brain mgm ± σm	Weight brain per 100 gm body weight	Mean QO_2 first 90 min µl ± σm	Final QO_2 180 min (no testosterone) µl ± σm	Final QO_2 180 min (testosterone added at 90 min) µl ± σm	Inhibition of QO_2 produced by testosterone	Wet/dry ratio
Normal	12	182 ± 8.1	1206 ± 29	663	6.5 ± 0.1 (35)†	4.3 ± 0.1 (25)	1.5 ± 0.1 (10)	65%	4.9
Castrate untreated	10	161 ± 4.1	1152 ± 21	716	8.6 ± 0.1 (72)	6.8 ± 0.1 (30)	5.3 ± 0.1 (42)	22%	4.7
Castrate treated	18	166 ± 8.3	1094 ± 26	659	6.9 ± 0.1 (80)	5.4 ± 0.1 (28)	2.6 ± 0.1 (52)	52%	4.7

* σm—Standard deviation of the mean.

† —Number of vessels in parentheses.

Male rats of the Long-Evans and Slonaker-Wistar strains were used. There were no significant differences between data derived from the two strains and therefore the results were pooled. Tissue respiration studies were performed upon three groups of animals: a group of normal males, a second group castrated at the age of 30 days, and a third group castrated at 30 days and afterward treated subcutaneously with 1 mg of testosterone propionate[1] per day. The rats were decapitated at 60 days of age and the QO_2 of brain was determined by the direct method of Warburg. Cell suspensions of cerebral hemispheres were prepared by the method of Potter and Elvehjem (*6*) in ice-cold modified Krebs' Ringer-phosphate buffer containing 0.2% glucose as substrate. One ml of a 10% homogenate was placed in a Warburg flask containing sufficient buffer and material in the sidearm to make a final volume of 2 ml. The vessels were placed in a bath at 37.2° C within 10 min after decapitation. The gas phase was oxygen. Each experiment lasted 3 hr with readings taken at 15-min intervals. When testosterone was added *in vitro*, 2 mgm of a fine suspension was added after a 90-min control period. QO_2 is reported as µl of oxygen per mgm of dry brain per hr. Wet/dry ratios were determined by the method of Crismon and Field (*1*).

Experimental data are summarized in Table 1. It will be observed that the brain of the castrated rat has an oxygen uptake 32% higher than that of the normal rat (p value < 0.01). The brain of the castrated rat treated with testosterone respires at a rate only slightly higher than normal ($p < 0.01$). The addition of testosterone *in vitro* further suppresses the oxygen uptake of all groups; however, the inhibition is far less in the castrated than in either the treated castrated or the normal group. It will further be observed that the QO_2 of the brain of the untreated castrated rat to which testosterone has been added *in vitro* (5.3) is essentially the same as that of the testosterone-treated castrated rat brain (5.4) at a comparable time. The rate of oxygen uptake by the brain of the treated castrated rat can be decreased to a still lower level (2.6) by the further addition of testosterone *in vitro*. The variations in QO_2 cannot be explained by difference in water content, since the wet/dry ratios of all groups are essentially the same.

Inasmuch as the potential enzymatic activity of certain tissues exceeds the actual activity found *in vivo*, the concept of the metabolic ''brake'' has been postulated (*4*, *5*). It appears that testosterone exerts such a ''braking'' action upon the oxidation of glucose by the rat brain. This is borne out by the high QO_2 of the castrated rat brain and the prevention of the rise of QO_2 by testosterone treatment *in vivo*. The further addition of testosterone *in vitro* is capable of lowering the QO_2 to subnormal levels in normal and testosterone-treated castrates. This is not the case with untreated castrates. In other words, the brain of the castrated rat is less sensitive to the oxidation-inhibiting effect of testosterone *in vitro* than is the brain of the normal rat or of the castrated rat treated with testosterone. A possible interpretation is that the intracellular concentration of the enzyme system by which testosterone exerts its inhibiting effect upon the oxygen uptake of brain is decreased after castration. This decrease can be prevented for the most part by the administration of testosterone.

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[1] Grateful acknowledgment is made to Dr. E. Oppenheimer, Ciba Pharmaceutical Products, Inc., Summit, New Jersey, for the testosterone propionate (Perandren) and the unesterified testosterone used in this study.

Comments and Communications

Glycine Reagent for Paper Chromatograms

Glycine on a paper chromatogram can be identified as a Hellebore green spot, chocolate brown under radiation in the region of 3650 A, by spraying with a solution of ortho-phthalaldehyde, previously described by the senior author as a colorimetric reagent (A. R. Patton, *J. biol. Chem.*, 1935, 108, 267). Interfering substances present in protein hydrolyzates (particularly ammonium ions) are dispersed by using 77% ethanol as the solvent mixture. (Aromatic solvent mixtures produce abnormal reactions. We have found ethanol to be satisfactory for ascending separation in a range between 65 and 85% by volume, and 77% ethanol $\left[\text{sp. gr. } 0.87\ \frac{60^\circ\text{ F}}{60^\circ\text{ F}}\right]$ the most suitable.) Rf values for individual amino acids with ascending irrigation on Whatman No. 1 paper were measured with ninhydrin as follows: cystine 0, lysine .21, arginine .26, aspartic acid .28, histidine .29, glycine .32, serine .37, tryptophan .38, glutamic acid .39, tyrosine and hydroxyproline .43, threonine .45, alanine .49, proline .55, methionine .64, phenylalanine .65, valine .68, leucine .76, isoleucine .77, and ammonium ions .57 (developed with glycine reagent).

In addition to identifying glycine, use of the reagent permits detection of ammonium ions (dark grey), and histidine and tryptophan (separate spots, intense yellow fluorescence under radiation around 3650 A). Among the compounds tested which cannot be detected by use of the glycine reagent are alanine, arginine, asparagine, aspartic acid, choline, creatinine, cystine, glutamic acid, glutamine, glutathione, glycine-betaine, hydroxyproline, isoleucine, leucine, lysine, methionine, nor-leucine, phenylalanine, proline, serine, threonine, tyrosine, and valine.

The method has been found satisfactory for the detection of glycine in the hydrolyzates of casein (low in glycine), gelatine (high in glycine), pilchard protein, Vegamine (a hydrolyzed plant protein), as well as in a mixture of 18 amino acids. Out of three commercial samples of hydroxyproline tested, one was found by this method to be contaminated with glycine.

The glycine reagent is apparently not yet available on the market. For the sample used we are indebted to Charles D. Hurd, Northwestern University. This sample was prepared as follows: 10 g o-bis(dibromomethyl) benzene was hydrolyzed according to the directions of Patton (*J. biol. Chem.*, 1935, 108, 267) with 9 g potassium oxalate, 62 ml each of water and 95% ethanol. The mixture was refluxed 41 hr with occasional shaking, after which 50 ml was distilled off, and added to 300 ml water containing 21.3 g trisodium phosphate dodecahydrate. The solution used as "glycine reagent" was obtained by distilling 300 ml from this mixture, melting out crystals as they appeared in the condenser. The colorless solution, stored in a brown bottle, was over 18 months old when used.

A. R. Patton and E. M. Foreman

Chemistry Department, Colorado A & M College, Fort Collins, Colorado

Nomenclature of the Soybean

In the paper published recently by P. L. Ricker and W. J. Morse (*J. Amer. Soc. Agron.*, 1948, 40, 190), the old question of the correct scientific name for the soybean was discussed again. According to the authors' point of view, *Glycine Max* (L.) is the name to be used for that plant. The authors base their arguments on the apparent fact that *Phaseolus Max* L. is the oldest specific name for the soybean. I wish to show later the status of this name. There is no doubt that Linnaeus' original description of *Phaseolus Max* in his *Species plantarum* (1753) has some specific characters derived from another element, namely *Phaseolus Mungo* L.; this may be proven by the reference to a name under *P. Max*, which was given to the plant, now being known under the name of *Phaseolus Mungo* L., by P. Herrmann in *Musaeum Zeylanicum* (1726). The majority of the botanists interested[1] consider *Phaseolus Max* L. to be identical with *Phaseolus Mungo* L. Furthermore, H. Trimen[2] proposed entirely to use the name of *P. Max* L. in favor of that of *P. Mungo* L.

Generally, the confused species *Phaseolus Max* L. would belong partially to the genus *Glycine*, partially to that of *Phaseolus*. On the other hand, the proper description of the soybean was made by Linnaeus under the name of *Dolichos Soja*, also in his *Species plantarum* (1753). On account of the above remarks it is evident that *Phaseolus Max* of Linnaeus must be considered as a *nomen confusum*. (*Int. rules of botanical nomencl.*, *Art. 64*: "A name of a taxonomic group must be rejected if the characters of that group were derived from two or more entirely discordant elements, especially if those elements were erroneously supposed to form part of the same individual.") Because of increasing use of the invalid name for the soybean,[3] *Glycine Max* (L.) Merrill, instead of the correct denomination *Glycine Soja* (L.) Siebold et Zuccarini, I hope this note may be useful.

Jiří Paclt

Prague, Czechoslovakia

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[1] Represented by W. Roxburgh (*Flora indica*, 1832).

[2] *Handbook of the flora of Ceylon*, 1894, 2, 72.

[3] Quite recently, the incorrect name *Glycine Max* has appeared also in a number of standard handbooks, e.g. C. D. Darlington & E. K. Janaki Ammal: *Chromosome atlas* (1945).

Two Ancient Archeological Sites in the Great Basin

During the years 1936 to 1942 my late husband William H. Campbell and I spent considerable time studying two ancient archeological sites in the Great Basin: one on ancient Lake Tonopah in Big Smoky Valley, Nevada, the other on the long abandoned shores of Owens Lake, California and along the old river channel which drained it southward. In 1936 and 1939 Dr. Ernst Antevs took part in the field work with us.

At both places Folsom, Pinto, and Mohave artifacts were found segregated from each other. These types of artifacts are described in the following papers: Frank H. H. Roberts, "A Folsom Complex: Preliminary Report on Investigations at the Lindenmeier Site in Northern Colorado," *Smithsonian misc. Coll.*, 1935, **94**; *idem*, "Additional Information on the Folsom Complex," *ibid.*, 1936, **95**; Elizabeth and William H. Campbell, David Scharf and Charles Amsden, "The Pinto Basin Site," *Southwest Museum Papers* No. 9, 1935; Elizabeth and W. H. Campbell, Ernst Antevs, Charles Amsden, J. A. Barbieri and F. D. Bode, "The Archeology of Pleistocene Lake Mohave," *ibid.*, No. 11, 1937.

The Lake Tonopah Site is located west of the city of Tonopah on and just north of pluvial Lake Tonopah, mapped and described by E. O. Meinzer (*U. S. Geol. Survey*, Water-Supply Pap. 423, 1917). Here the artifacts were found on the surfaces of the beaches in the following descending order, or from older to younger: First, Mohave, second Folsom, third Mohave, fourth Pinto. Hence Mohave artifacts occur on both higher and lower beaches than the Folsom objects. Of Folsom implements there were hundreds gathered, mostly on a sandy ridge bordering Peavine Creek, which flows into the basin in wet years and on the adjoining gravel shores of the ancient lake. Typical specimens are pictured in "A Folsom Complex in the Great Basin, the Master Key," by Elizabeth and William H. Campbell, January 1940, pp. 7–11. Barring the deeply grooved Folsom points, everything found at Dr. Roberts' Lindenmeier Site was represented, and all other Folsom artifacts, including slightly fluted points, resembled in detail the tools from Lindenmeier. In Dr. Roberts' present view the assembly is not true Folsom, since it lacks the deeply fluted point, which he regards as the crucial criterion ("Evidence for a Paleo-Indian in the New World," *Acta Americana*, 1943, 1, 171–201; see p. 173).

While the Folsom here could be associated with Peavine Creek, it seems more reasonable to associate it with the old lake features no later than the last great pluvial period, and the fact that there is no change in work tools precludes any great passage of time in its spread from the Great Plains to southern Nevada.

The site is of value for two reasons: first because of the presence and the relative distribution of Folsom, and second because post-Pinto cultures occurring in the deeper parts of the basin show what followed the old complexes here, down to the recent Indian occupation.

At Owens Lake we have a series of beaches descending from the crest of a bar at 3,675 elevation, or 128 feet above the playa flat, to the lowest shore lines merging into the surface of the present bare playa. The crest stands some 85 feet below the old overflow channel at about 3,760 feet (H. S. Gale, in *U. S. Geol. Survey Bull.* 1915, **580**, 256).

On the crest we found Mohave artifacts extending for some miles across the north shore of the lake, while to the north and farther back from the lake, and possibly at a few feet lower level, were Pinto artifacts.

On the lake side of the crest the next lower and thus younger second beach was barren of artifacts. The third beach contained Folsom artifacts and although there was no such concentration of artifacts as occurred on the Nevada site, there was nothing found on this beach except Folsom. Thus the three types of artifacts were fully segregated, nowhere mixed.

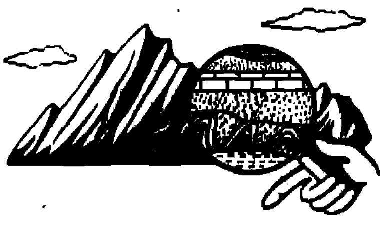
Below the fourth beach there is a zone of sandhills which, occurring at this level nearly all the way around the lake, could have been blown up during the very arid period following the end of the last glacio-pluvial period. Above the sand dunes the beaches are tremendous in sweep and width, while below they are small and narrow. It is on these latter beaches that modern Indian arrowpoints and artifacts are found.

We followed the ancient continuation of the Owens River southward past Haiwee reservoirs, through the old gorge into Rose Valley, and below and through Rose Valley to Little Lake and China Basin beyond. We found good sites a mile or two north of Little Lake near the extinct volcano and around a dry waterfall worn by the old river.

Accordingly, with the exception of the deeply grooved Folsom points, the entire assemblage of artifacts found at the foremost Folsom site—the Lindenmeier in Colorado—have also been found on the pluvial Lakes Tonopah and Owens; and they occur on beaches at slightly different levels than do the Mohave and Pinto implements, which also are segregated.

ELIZABETH W. CROZER CAMPBELL

Green Pastures Ranch,
Carson City, Nevada



In Memoriam

William Thomas Shaw

1873–1948

William T. Shaw, professor emeritus of zoology at Fresno State College, was a naturalist who began an intimate association with the out-of-doors when he was a small boy in southern Ontario, Canada, and who continued to find in nature an all-absorbing interest until the end of his 75 years.

Only a few professional biologists today can be called naturalists. William T. Shaw was outstanding in this select group because of the completeness with which he devoted his life to the study of nature. He never married. During the 20 years of his residence in Fresno he owned no local property, and the time that men generally devote to their families, gardens, and golf he gave to biology.

Most of his waking hours were spent in teaching, writing, photography, and taxidermy, in the interests of his beloved Fresno Natural History Society, and in preparing a unique series of habitat cases (*Scientific Monthly,* Feb. 1945, pp. 97–107) which reproduce typical scenes across the middle of California. Even though he was always occupied with some job in biology, he was never too busy to mount, with rare skill, a bedraggled specimen brought in by a Boy Scout, or to welcome a shy little girl who wanted to see his pet kangaroo rats.

Time and again I urged him to write the story of his 65 years as a student of nature. It would have made good reading—his 100-mile voyage down the Mississippi River in a birch-bark canoe ('95); his work as an undergraduate in Minnesota under the entomologist, Otto Lugger, at 10 cents an hour ('94–'98); his field trips, many of them with distinguished companions; the successful careers of his students; his collecting for the Museum at Oregon State College; his bird-collecting adventures in Alaska ('07 and '08) and experiences in exhibiting the collection at the Alaska-Yukon-Pacific Exposition ('09); his long service as curator of the Connor Museum at Pullman, Washington; his work at the New York State Museum ('27), mountain climbing, and ranching in Saskatchewan. Well, he would say, he might write the story someday, but right now there was too much to be done that was more important. There was that long manuscript on the birds of Washington (by Walter P. Taylor, William T. Shaw, Stanley G. Jewett, and John W. Aldrich) to read over again, and his monograph on the Columbian ground squirrel must be completed. My insistence got me nowhere except to a surer realization that it was no use trying to influence the plans of William Thomas Shaw.

Nearly all of his life he had college loyalties: to the Ontario Agricultural College, where his father, Professor Thomas Shaw, was a teacher of agricultural subjects; to three institutions where he earned degrees—the University of Minnesota (B.Agr. '98, B.S. '99), Michigan State College (M.S. '00), and Stanford University (Ph.D. '26); and to Iowa State College, Oregon State College, the State College of Washington, the University of Redlands, and Fresno State College, where he taught. His teaching included zoology, ornithology, entomology, museum management, taxidermy, bacteriology, and botany.

All who knew William T. Shaw admired his determination. A slender, fairly tall man, he was forced to walk with a cane because of a leg crippled by infantile paralysis when he was less than a year old. In spite of this handicap he climbed mountains, explored marshes and tide pools, and trapped along rugged streams, all with never a complaint. His halting gait was slow but persistent, and as often as not he was among the first in the party to reach the summit of a climb.

Dr. Shaw's boyhood in Woodburn and Guelph, Ontario, was spent in the same region where Ernest Thompson Seton lived during his early years as a farm boy. Seton, John Muir, John Burroughs, and Donald Culross Peattie were his favorite authors. At its best his own prose was of high quality. His last letter to me, written during the final summer in Saskatchewan, contained the following paragraph:

> Last week it was reported that the Cree Indians were celebrating their Sun Dance, which takes place near here. On invitation I went over, little suspecting to come suddenly upon a very memorable sight. It was evening, and, as we came to the crest of a hill, beyond and below us was a sight to remember. In a great circle lay over a hundred and sixty tepees and tents, with a great ceremonial space within. To one side lay a distant coulee tinted with evening glow, and from the camps and tepees rose grey, vertical columns of smoke. To us there arose the chant of the dancers and, what seemed best of all, the treble voices of children all over the huge circle. What a farewell to day! As dusk closed in there came distantly the call of a lark singing.

PEREZ SIMMONS

Fresno, California

Scientific Book Register

Cole, Lewis Gregory. *Lung dust lesions (Pneumoconiosis) versus tuberculosis.* White Plains, N. Y.: American Medical Films, 1948. Pp. xxii + 474. (Illustrated.) $10.00.

DeGowin, Elmer L., Hardin, Robert C., and Alsever, John B. *Blood transfusion.* Philadelphia-London: W. B. Saunders, 1949. Pp. xii + 587. (Illustrated.) $9.00.

Dushman, Saul. *Scientific foundations of vacuum technique.* New York: John Wiley; London: Chapman & Hall, 1949. Pp. xi + 882. (Illustrated.) $15.00.

Gallet, Etienne. *Die Flamingos der Camargue.* Thun, Switzerland: Werner Krebser, 1949. Pp. 127. (Illustrated.)

Githens, Thomas S. *Drug plants of Africa.* (African Handbooks: 8, Committee on African Studies, University of Pennsylvania.) Philadelphia: Univ. Pennsylvania Press, 1949. Pp. vii + 125. $2.25.

Hellmayr, Charles E., and Conover, Boardman. *Catalogue of birds of the Americas and the adjacent islands in Field Museum of Natural History: Charadriiformes,* Pt. 1, No. 3. (Publ. 616.) Chicago: Field Museum, 1948. Pp. vi + 383. $4.00.

Honeyman, John. *An introduction to the chemistry of carbohydrates.* Oxford, Engl.: Clarendon Press; New York: Oxford Univ. Press, 1949. Pp. 143. (Illustrated.) $4.50.

Kuiper, Gerald P. (Ed.) *The atmospheres of the earth and planets: papers presented at the Fiftieth Anniversary Symposium of the Yerkes Observatory, September, 1947.* Chicago: Univ. Chicago Press, 1949. Pp. vii + 366. (Illustrated.) $7.50.

Mitchell, John Jr., and Smith, Donald Milton. *Aquametry: application of the Karl Fischer reagent to quantitative analyses involving water.* New York: Interscience, 1948. Pp. xi + 444. (Illustrated.) $8.00.

Montgomery, D. J. X. *Cosmic ray physics.* Princeton, N. J.: Princeton Univ. Press, 1949. Pp. viii + 370. (Illustrated.) $5.00.

Scholes, France V., and Roys, Ralph L. *The Maya Chontal Indians of Acalan-Tixchel: a contribution to the history and ethnography of the Yucatan Peninsula.* (Publ. 560.) Washington, D. C.: Carnegie Institution, 1948. Pp. x + 565. (Illustrated.) $3.50 paper; $4.75 cloth.

Sicher, Harry. *Oral anatomy.* St. Louis, Mo.: C. V. Mosby, 1949. Pp. 529. (Illustrated.) $15.00.

Silver, Samuel. (Ed.) *Microwave antenna theory and design.* (Massachusetts Institute of Technology Radiation Laboratory Series.) New York: McGraw-Hill, 1949. Pp. xviii + 623. (Illustrated.) $8.00.

Woglom, William H. *Discoverers for medicine.* New Haven, Conn.: Yale Univ. Press, 1949. Pp. x + 229. (Illustrated.) $3.75.

(*Continued from page 328.*)

calibration exposures with the abscissa expressed in terms of the log of the fractional dosage. By fractional dosage is meant the ratio of the dosage rate in the calibration source to the bone dosage rate which would have existed had the bone been formed from the blood calcium at the instant of its highest specific activity. (It is assumed here that the *maximum* calcium concentration in bone is 36 percent by weight, the measured concentration in bone ash [*4*].) The blackening for each bone site labeled in Fig. 1 is indicated on the vertical scale of Fig. 2, from which it is seen that the maximum fractional dosage in the dog rib, corresponding to sites 2 and 3, is the antilog of $\bar{2}.26$, or .018.

The importance of this fact is its application to the possible use of radioactive Ca^{45} as a tracer in human beings. If such an experiment is to be carried on with reasonable convenience, this isotope will have to be present in the blood in a concentration of at least 1 μc/gm Ca. If bone were formed directly from such calcium, the dosage rate would be a forbidden 1.9 reps/day (again assuming 36 percent maximum calcium concentration). However, if the same dilution existed in humans as in the particular dog rib studied, the maximum local dosage rate would be a permissible value of (.018) (1.9) = 0.034 reps/day. It is important to notice, however, that this maximum local dosage rate is approximately six times higher than the average rate in the bone as a whole as determined by counter measurements on the digested rib.

Further work is planned in the quantitative study of film characteristics for different types and energies of radiation, and in the development of calibration sources which can be cut simultaneously with soft tissue, using a microtome technique.

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NEWS and Notes

1949 Annual Meeting of the AAAS. The 116th Meeting of the American Association for the Advancement of Science will be held December 26–31, 1949, in New York City. The Association has held only five meetings in this city—the last, 21 years ago. The other occasions in New York were in 1916, 1906, 1900, and 1887. The 115th Meeting commemorated the Association's Centennial, September 13–17, 1948, in Washington, whereas the last meeting during the Christmas holidays—the period preferred by a large majority of the members—was held in 1947 in Chicago.

All plans for 1949 are based on the assumption that this will be the largest gathering of representatives from the 17 sections and subsections and 206 affiliated and associated societies in the 101 years of the AAAS. It will undoubtedly be one of the most convenient meetings from the standpoint of all concerned. The Statler Hotel (formerly the Pennsylvania) will be the headquarters for the Annual Science Exposition, Main Registration, Visible Directory, New Member Service, and Science Theatre. Its four close neighbors, the New Yorker, McAlpin, Governor Clinton, and Martinique, have also pledged their public rooms for the convention period. Thus, related societies may be grouped together and it is probable that *most* of the papers will be read in rooms so close together that those who so desire can readily attend a variety of sessions. These Penn Zone hotels also have made commitments for 3,500 sleeper rooms, many of them double, so that adequate accommodations are assured. The New York Convention Bureau will handle all room reservations and hotels will send prompt confirmations directly. *Science* will announce soon which societies are meeting with the Association, and the hotels at which their meetings will be held. Advance registration and hotel room reservation will begin in September.

Frank A. Geldard, on leave of absence from the University of Virginia, has been appointed research chief of the Human Resources Branch, Division of Research and Development, Department of the Air Force, Washington, D. C.

Thomas Park, on leave of absence from the University of Chicago, has left for London, where he will be senior scientific officer of the American Embassy.

David Rittenberg, associate professor of biochemistry, College of Physicians and Surgeons, Columbia University, will deliver the seventh Harvey Lecture of the current series at the New York Academy of Medicine on April 28. His topic will be "Dynamic Aspects of the Metabolism of Amino Acids."

E. D. Friedman, staff member of New York University since 1909, was guest of honor at the Alumni Dinner of the University College of Medicine held recently.

Stanley Wing Handford, Brown University, has been named senior physiologist at the Naval Medical Field Research Laboratory, Marine Barracks, Camp Lejeune, North Carolina, April 1.

Recently appointed members of the permanent U. S. Atomic Energy Commission's Personnel Security Review Board are **Charles Fahy,** former Solicitor General of the United States, who will serve as chairman; **Arthur S. Flemming,** president of Ohio Wesleyan University; and **Bruce D. Smith,** director of the United Corporation, New York City. The Board will review individual personnel security cases, and advise the commission on personnel security standards and procedures.

Henry M. Leicester, professor of biochemistry at the College of Physicians and Surgeons, San Francisco, has been named to succeed the late Tenney L. Davis, as editor-in-chief of *Chymia: annual studies in the history of chemistry.* **John Read,** director of the Chemistry Research Laboratory, University of St. Andrews, Scotland, is the new associate editor.

C. C. Burlingame, consulting psychiatrist, recently visited India on a speaking tour by invitation of the Indian Psychiatric Society. While there he addressed the All-India Medical Conference at its silver jubilee meeting in Calcutta, and the annual meeting of the Indian Science Congress in Alla Habad.

Irven Travis, former supervisor of research at University of Pennsylvania's Moore School of Engineering, has been appointed director of research of the Burroughs Adding Machine Company. Dr. Travis will continue to be a member of the university faculty.

Pablo Morales-Otero, director of Puerto Rico's School of Tropical Medicine, has been appointed to the medical faculty of Columbia University.

R. H. Wiswall, Jr., supervisor of research in physical chemistry for the Carbide and Carbon Chemical Corporation's gaseous diffusion plant at Oak Ridge, has recently joined the staff of Brookhaven National Laboratory in the Department of Reactor Science and Engineering.

Emanuel B. Schoenbach, Department of Preventive Medicine, Johns Hopkins University School of Medicine, will serve as visiting Commonwealth Professor of Medicine at the University of Louisville School of Medicine, April 17–23. He will present a series of discussions on "The Mechanism of Actions and Indications for the Newer Antibiotics," "The Treatment of Rickettsial Infections," and "Experimental Investigations on the Chemo-Therapy of Neoplasms."

Eugene Callaghan, Department of Geology, Indiana University, has been appointed director of the New Mexico Bureau of Mines and Mineral Resources Division of the New Mexico School of Mines, Socorro. He will take over his new duties in September.

Donald B. Keyes, vice president in charge of planning and development of the Heyden Chemical Corporation, New York City, will be presented with the first Honor Scroll of the New York chapter of the American Institute of Chemists, for his service and devotion to young chemists. He will receive the award May 18, at a dinner meeting of the Institute.

Visitors

Miguel Catalan, professor of atomic physics at the University of Madrid, is guest lecturer at Wilson College this month. He is lecturing on physical problems and working with students in the department of physics on spectroscopy and atomic physics.

H. M. S. Coxeter, professor of mathematics of the University of Toronto, has been named visiting professor at Barnard College, Columbia University, for the spring session.

Grants and Awards

The Research Corporation Scientific Award was recently presented to Bruno Rossi, professor of physics at the Massachusetts Institute of Technology, for distinguished research in the fields of cosmic radiation and properties of mesons, and for his work in nuclear fission. Dr. Rossi received a plaque and $2,500.

The National Dairy Council, Chicago, has announced its 1949 research program, involving an expenditure of $75,000. Funds for the projects are provided either by the American Dairy Association, Chicago, or the National Dairy Council. Grants for nutritional research in the use of dairy products have been made to: Michigan State College, University of Chicago, University of Wisconsin, Iowa State College, Texas A. & M., University of Rochester, University of Illinois, University of Minnesota, University of Nebraska, Harvard University, and University of Massachusetts, and the University of Michigan.

The American Academy of Arts and Sciences has chosen Ira S. Bowen, director of the Mount Wilson and Palomar Observatories in California, as recipient of the 1949 Count Rumford medals, for discoveries in the fields of heat and light.

National Cancer Institute grants totaling $451,622 for cancer teaching and control have been announced by the Federal Security Agency. Nine control grants totaling $170,205 were approved. Three of these, amounting to $69,114, are new grants, to finance a state environmental cancer study in Pennsylvania and two cancer diagnostic test projects, at the University of California and the University of Colorado. Two new teaching awards were made, one of $23,339 to Vanderbilt University School of Medicine and one of $5,000 to the University of Southern California School of Dentistry.

The Royal Society of Edinburgh will award its David Anderson-Berry medal for 1950 to the person who, in the opinion of the Council, has recently produced the best work on the therapeutical effect of X-rays on human diseases. About £100 goes with the award. Both published and unpublished works are acceptable and should be accompanied by copies of relevant papers. Applications must be in the hands of the General Secretary, Royal Society of Edinburgh, 22 George Street, Edinburgh 2, Scotland, by March 31, 1950.

William C. Rose, University of Illinois, has been selected to recieve the first **Osborne and Mendel Award** of the American Institute of Nutrition. Professor Rose was associated with the two founders of the award at Yale.

The General Electric Company has awarded from its Educational Fund $18,460 in research fellowships to 15 graduate students for advanced study in scientific and industrial fields during 1949. Seven of the students received the Charles A. Coffin Fellowships, for study in electricity, physics, and the physical sciences. Eight others were awarded the Gerard Swope Fellowships, for study in industrial management, engineering, and the physical sciences. The winners received up to $1,500, plus a grant for special equipment needed in their chosen field.

Fellowships

The University of Rochester has established five three-year Bausch-Lomb scholarships to go to graduates of Puerto Rican high schools. Both boys and girls are eligible, and the scholarships amount to $1,500 each, to be used over the three-year period in study of the sciences.

The Watson Scientific Computing Laboratory at Columbia University announces two $2,000 fellowships in applied mathematics during the academic year 1949–1950, for study and research relating to large scale calculating operations. Application blanks may be obtained from the Office of Admissions, Columbia University, New York City, and must be returned before *April 15*.

Lehigh University announces the following fellowships available for the academic year 1949–1950: Two du Pont Company fellowships—one in mechanical, one in metallurgical engineering ($1,200 to $1,800); one Westinghouse fellowship in mechanical engineering ($1,000); and one George Gowen Hood fellowship in any field of work in which the University offers a doctorate ($1,500). Application blanks may be had by writing Dean Wray H. Congdon, Director of Admissions, Lehigh University, Bethlehem, Pennsylvania.

Battelle Memorial Institute offers a limited number of predoctoral research fellowships and postdoctoral research associateships for the year 1949–1950. The fellowships, open to men, U. S. citizens, seeking a doctor's degree in a science or in engineering, are available for the final year of graduate study. Fellows receive $1,200 a year, plus expenses. Preference for associateships will be given to men who hold the Ph.D. degree, and stipends will be determined by the associates' preparation, experience, and promise. Further information may be had by writing to the Institute, 505 King Avenue, Columbus 1, Ohio.

The New York Zoological Society announces a veterinary research fellowship of $500 for three months—June 15–September 15, at the New York Zoological Park. The recipient must have a veterinary degree from an American Veterinary Medical Association approved college, and show special interest in such fields as zoology, wildlife management, comparative anatomy, physiology, bacteriology, parisitology, and pathology. Applications should be addressed to Leonard J. Goss, Veterinarian, New York Zoological Society, Zoological Park, New York City 60.

Lehigh University has announced the establishment of a new **International Nickel Company** research fellowship for work in the fields of nickel, copper, and the platinum metals. The first recipient of the $1,500 award will be named later this year and will start work in September in the University's department of metallurgy.

Research fellowships in mathematics and mathematical physics for the summer of 1949 and the academic year 1949–1950 are offered to qualified graduate students by the Institute for Numerical Analysis of the National Bureau of Standards, located at the University of California, Los Angeles. The research work, to be done at the Institute, will be aimed at methods for advancing the application of high speed automatic digital computing machinery. Stipends are based on full-time annual salaries of $2,294 for master's degree candidates, and $3,727 for doctoral candidates. Further information and application forms may be obtained from the Chief, Institute for Numerical Analysis, 405 Hilgard Avenue, Los Angeles 24.

Colleges and Universities

The University of Illinois Chemistry Department has been awarded $10,000 by the E. I. du Pont de Nemours Company for fundamental research. C. S. Vestling and B. R. Ray will be assigned $7,000 for research on the purification and characterization of the enzyme, rat liver lactase dehydrogenase. H. G. Drickamer will receive $3,000 for research on nuclei formation in the critical region between the gaseous and the liquid state.

The Ohio State University Development Fund has received a second gift of $1,000 from John W. Galbreath, of Columbus, for research, particularly on cancer, in the University's Department of Medicine. The study will be under the direction of Charles A. Doan, dean of the College of Medicine.

The University of Illinois College of Agriculture is investigating methods of killing bacteria in milk or water by use of ultrasonic waves. The research is being carried on by Robert M. Whitney, professor of dairy technology, and Lillian A. Russell, Illinois State Water Survey chemist. No reportable results are expected for at least a year.

Lehigh University Institute of Research, in cooperation with the David E. Kennedy Corporation of Brooklyn, New York, has obtained fundamental data supporting the performance of finned tubing as about eight times better than plain tubing in heat exchange applications. Darrel E. Mack is director of the project.

Construction will start on the **University of California's new medical center** during the spring of 1950, when two major buildings—a medical science building and a 500-bed teaching hospital—go up on the site of the present medical center, in San Francisco. A total of $21,080,000 is now earmarked for construction—$20,015,000 of state funds, $1,000,000 from the U. S. Public Health Service, and $65,000 donated by Mr. and Mrs. Berthold Guggenhime.

Harvard University has created a new Division of Engineering Sciences within the Faculty of Arts and Sciences in order to help bridge the gap between pure science and the technology of engineering. The new division, under the chairmanship of Gordon M. Fair, present dean of the Graduate School of Engineering, will consist of two departments. The Department of Engineering Sciences and Applied Physics will offer graduate training in applied mathematics, applied physics, and electrical and communication engineering, directed by Emory Leon Chaffee; and the Department of Engineering a graduate program in applied mathematics, civil, electrical, and sanitary engineering, directed by Albert Haertlein.

Industrial Laboratories

Albert D. Fisher, formerly technical director of Oxford Products, Inc., has been appointed head of the newly organized **Midwest Chemical Development Corporation,** Cleveland Ohio, manufacturers of pharmaceutical products. I. Levis, former faculty member of Case Institute of Technology and Fenn College, will be vice president in charge of research and production.

Schenley Laboratories, Inc., has announced that large scale production and marketing of streptomycin will soon begin at its Lawrenceburg, Indiana plant. Schenley is also reducing prices 10 to 25 percent on three penicillin products. This is the third such reduction in a year affecting the pure crystalline penicillin and its compounds aquacillin and monocillin. The wholesale price is now less than one-eighth that of March 15, 1945.

Smith, Kline & French Laboratories, 108-year-old pharmaceutical manufacturing firm, opened a new $7,000,000 building at 15th and Spring Garden Streets, Philadelphia, on March 12. The new building and grounds occupy a full city block and the space given to scientific research has been increased five times over that provided by former quarters. To carry new therapeutic agents progressively from chemical synthesis through animal testing, pharmacy, and bacteriology, the laboratories have been designed so that organic chemistry, pharmacology, research analytical and biochemistry laboratories are grouped on the fifth floor and pharmaceutical chemistry, bacteriology, and physical chemistry on the fourth.

Meetings and Elections

Stanford University School of Medicine announces its 67th course of **Popular Medical Lectures** to be held at Lane Hall, San Francisco, April 6, April 20, and April 27 at 8:00 p.m. Subjects of the lectures are: "Cancer of the Uterus," "Poliomyelitis: Means of Spread and Control," and "The Prevention and Treatment of Blindness in Childhood." All interested are invited to attend.

The **Institute of Mathematical Statistics** will hold its 38th meeting at Columbia University April 8–9. "Applications of Multivariate Analysis" will be discussed by John Wishart, Cambridge University; Harold Hotelling, University of North Carolina; and S. N. Roy, Presidency College, Calcutta.

The 16th International Geographical Congress will meet in Lisbon April 8–15. Members of the official U. S. delegation representing the National Research Council are: George B. Cressey, chairman; Wallace W. Atwood, Jr., S. W. Boggs, Edwin J. Foscue, Otto E. Guthe, S. Van Valkenburg, and John K. Wright. The American delegation will present a number of proposals for new commissions, dealing with the International Map of the World, standardized spelling for place names, and the development of tropical areas.

The **Acoustical Society of America** will hold its 20th anniversary meeting May 5–7, at the Statler Hotel in New York City. Among the invited speakers are Philip M. Morse, Massachusetts Institute of Technology; Vern O. Knudsen, University of California at Los Angeles; and Harry F. Olson, RCA Laboratories. The research to be reported at the meeting will be grouped according to its function in relation to man, as follows: acoustics in comfort and safety, as a tool in physics, in the arts, and in communication. Those wishing to attend may obtain further information from Harold Burris-Meyer, Stevens Institute of Technology, Hoboken, New Jersey.

The International Association for Dental Research's New York Section will hold its May meeting at the New York University College of Dentistry on May 5. Members and guests wishing to present papers should communicate with the Secretary of the Association, 209 East 23rd Street, New York City 10.

The **Ohio Academy of Science** will hold its 58th annual meeting at Denison University, Granville, Ohio April 21–23. George B. Barbour, University of Cincinnati, will give the presidential address on the topic, "Ape or Man? The Recent Discoveries in South Africa."

Dana Coman, scientific advisor to the War Department General Staff, has been elected president of the **American Polar Society**. Vice presidents elected were: Laurence M. Gould, president of Carleton College; Thomas C. Poulter, director of Stanford Research Institute; and Finn Ronne, U.S.N.R., of Washington. All are polar expedition veterans. Russell J. Walrath, New York Times, was re-elected treasurer, and August Howard of New York, was again chosen secretary.

The **National Bureau of Standards** will hold two symposia on the effective utilization of automatic digital computing machinery, both at the Bureau's Institute for Numerical Analysis in Los Angeles: Symposium I: "Construction and Applications of Conformal Maps," tentatively planned for June 24–25; Symposium II: "Probability Methods in Numerical Analysis," tentatively planned for June 27–29.

Deaths

Vincente Inglada Ors, 70, geophysicist and chief of the Spanish Seismological Service, died January 9.

Herbert H. King, 66, professor and head of the Chemistry Department, Kansas State College, from 1918 until his retirement in 1948, died in Manhattan, Kansas on March 11.

Samuel F. Hildebrand, 65, ichthyologist, died suddenly on March 16 in Washington, D. C. Dr. Hildebrand had served as director of the U. S. Fisheries Laboratory in Beaufort, North Carolina, as an ichthyologist for the Department of the Interior, and more recently as a staff member of the Smithsonian Institution.

George Burr Richardson, 76, senior geologist of the U. S. Geological Survey from 1900 until his retirement in 1942, died March 18 in Washington, D. C.

Cleveland Norcross, 37, general manager of the American Institute of Physics, died March 21 in New York City after an emergency operation for a brain tumor.

Harvey C. Rentschler, 67, visiting professor of engineering at Princeton University and retired research director of the Westinghouse lamp division, died in East Orange, New Jersey on March 23.

The first Military Government German Industrial Exhibition will be held at the Museum of Science and Industry, Rockefeller Center, New York City, April 9–24 under the auspices of the U. S., British, and French Military Governments. Aimed at re-introducing the peacetime products of western Germany to American purchasers, the Fair will have over 500 exhibits displaying a variety of imports, including X-ray equipment, textiles, precision instruments, photographic apparatus, pharmaceuticals, electrotechnical and optical products, and dental apparatus. The public is invited to attend the Fair any day from 1 p.m. to 10 p.m. Between 10 a.m. and 1 p.m. Monday through Friday, the exhibit is open to buyers exclusively.

The Army Medical Service Corps has a number of vacancies in the grades of 2nd and 1st lieutenants in the following specialties: bacteriology, biochemistry, parasitology, serology, entomology, nutrition, toxicology, industrial hygiene, optometry, psychiatric social work, clinical psychology, and sanitary engineering, under the provisions of the Department of Army Circular 210, dated July 14, 1948. Further information may be obtained from the National Military Establishment, Department of the Army, Office of the Surgeon General, Technical Office, Washington 25, D. C.

The Unified Screw Thread system agreed upon by Great Britain, Canada, and the U. S. by the Declaration of Accord signed last November in Washington, has recently been given final approval by the American Standards Association. A detailed analysis of the new system has been made, presenting in tables, diagrams, and formulas the dimensions of the unified threads, and also those threads which at present are standard in the U. S. alone. This analysis B1.1–1949 "Unified and American Screw Threads for Bolts, Nuts, and Other Threaded Parts" may be had by writing the American Standards Association, Inc., 70 E. 45th St., New York City 17.

Make Plans for—

American Association of Physical Anthropologists, April 11–13, Wistar Institute, Philadelphia, Pennsylvania.

1949 Conference of Corrosion Engineers, April 11–14, Cincinnati, Ohio.

6th Western Metal Congress and Western Metal Exposition, April 11–15, Shrine Convention Hall, Los Angeles.

Electrochemical Society, April 13–16, Philadelphia, Pennsylvania.

The Neutron Pile as a Tool in Quantitative Analysis; The Gallium and Palladium Content of Iron Meteorites

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THE SCIENCE OF METEORITICS has come to be looked upon in recent years as a science of increasing importance, largely because of its recognized bearing upon astrophysical problems. In particular, it now appears likely that an intensive study of the distribution of elements in meteorites will enable one to draw important conclusions concerning the structure of planets, the origin of our solar system, and the relative "cosmic" abundances of the chemical elements (*1, 2*).

Unfortunately, with the exception of a very few common elements such as oxygen, silicon, magnesium, iron, nickel, and calcium, elements are found in meteorites in quantities of only a few parts per million (*3, 4*). Assaying the concentration of these rarer constituents of meteorites with an accuracy of 10% or better, as we often wish to do, presents grave analytical problems. V. M. Goldschmidt (*4*), Hevesy (*6*), and the Noddacks (*11*), who did much of the excellent earlier work on assaying the rarer constituents of meteorites, used at one time or another straightforward quantitative chemical methods, X-ray spectroscopy, and chemical spectroscopy. While their work has been very useful, the difficulties inherent in such analytical work gave rise to errors which appear in many cases to be greater than factors of two, and in some cases as great as a factor of ten.

If marked progress is to be made in the application of meteorites to cosmological problems, it seems clear that analytical techniques are needed which will satisfy the following criteria: (1) The method must permit an accuracy of 10% or better in determining the concentration of a given element present in the concentration range of 0.01 ppm to 500 ppm; (2) there must be no interferences from other chemical elements; (3) there must be no danger of contamination during the analysis; (4) the method must be reasonably rapid. A survey of various possible analytical approaches to the problem led the authors to the conclusion that a radiochemical technique offered the most promise.

The General Method. The concept of utilizing neutron activation as an analytical tool is by no means new. As early as 1936 Hevesy and Levi (*7*) applied the neutron activation method of analysis to the rare earth elements. They were able to find the 2½-hr dysprosium period in a sample of yttrium, after activation with neutrons, and thus demonstrated the presence of dysprosium impurity to an extent of 1%. Using the same method, Hevesy and Levi were also able to detect small amounts of europium in gadolinium samples (*8*). Since that time, modifications of the method have been used for semiquantitative studies of elements possessing relatively high neutron activation cross sections.

Most elements when irradiated by slow neutrons give rise to radioactive species of the same atomic number. The specific activity produced in a given element by neutron irradiation depends upon the neutron capture cross section of the isotope giving rise to the activity when it captures a neutron, the abundance of the isotope, the neutron flux, the half-life of the radioactive species, and the length of the irradiation: $a = N\sigma f(1 - e^{-\lambda t})$ where a = activity (disintegrations/sec), N = number of atoms of the nuclear species giving rise to the activity, σ = neutron capture cross section of species per atom (cm^2), f = neutron flux (neutrons/cm^2/sec), λ = decay constant of radioactive product, t = length of irradiation.

With the advent of the neutron pile, neutron fluxes capable of producing very high specific activities have become available. For example, the flux of the order of 10^{12} neutrons/cm^2/sec available in the heavy water pile at the Argonne National Laboratory is capable

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[1] The authors wish to thank Professor Lincoln La Paz, of the Institute of Meteoritics, University of New Mexico, for many of the samples used in this study. We are also indebted to Dr. S. Roy, of the Chicago Natural History Museum, who supplied us with several specimens, to Mr. H. H. Nininger, of the American Meteorite Museum, who made available a number of specimens, and to Professor Cyril Smith, of the University of Chicago, who supplied us with a specimen of the Carleton meteorite. Mr. Richard Deschamps helped with much of the counting and with certain phases of the experimental work.

of producing, in many elements, specific activities of the order of magnitude of 100,000–1,000,000 disintegrations/min/µg of element. Such specific activities make it possible to carry out the following general procedure: (1) A portion of the substance to be analyzed is irradiated in the pile, together with a standard consisting of a known weight of the element being determined; (2) the unknown is dissolved and a known weight of the element being determined is added to the solution; (3) the element added is chemically processed in order to free it from the activities associated with other elements present in the unknown; (4) the chemical yield of the procedure is determined; (5) the activity of the element in the unknown is compared with that of the standard; and (6) the purity of each activity is checked by measurements of half-lives and absorption spectra.

TABLE 1

SENSITIVITY OF PILE ANALYTICAL METHOD FOR CERTAIN ELEMENTS

(Argonne Heavy Water Pile, 7-hr bombardment at highest flux)

Element	Sensitivity (µg)	Element	Sensitivity (µg)
Na	0.01	Cu	0.004
Si	0.8	Ga	0.01
P	0.4	Ge	2.0
S	700.0	As	0.005
K	0.1	Rb	1.0
Ca	100.0	Sr	300.0
Sc	0.3	Y	0.05
Ti	400.0	Zr	2.0
Cr	1.0	Mo	0.7
Mn	0.008	Pd	0.005
Fe	700.0	Ag	5.0
Ni	0.1	Dy	0.00001

Table 1 gives examples of the estimated sensitivity of the neutron irradiation method for various elements in the Argonne heavy water pile. The term "sensitivity" is used here in a sense differing somewhat from its usual connotation in connection with analytical methods. In this paper the term is used to indicate the smallest quantity of an element that will give rise to an activity sufficiently intense to permit the measurement of half-life and absorption after the element has been exposed to the central pile flux for a period of 7 hr. Thus "sensitivity" here denotes the smallest quantity of an element that can be measured with a precision better than 10%, utilizing the central flux of the Argonne Pile for a time not unduly long.

It can be seen that the sensitivities obtainable are in general quite satisfactory, and in some cases are remarkable. The cases of manganese, copper, arsenic, palladium, and dysprosium, shown in Table 1, are particularly noteworthy. If one assumes that a half-life of 30 min represents the shortest life-time practicable for analytical determination, then the method is applicable to about 60 of the 75 stable elements existing in nature (excluding the rare gases). The method either cannot be applied or can be applied only with difficulty to hydrogen, lithium, beryllium, boron, carbon, nitrogen, oxygen, fluorine, magnesium, aluminum, vanadium, cobalt, columbium, and rhodium. In general, the pile method of analysis is more sensitive for elements of odd atomic number than for elements of even atomic number, because nuclear species of odd mass number have larger activation cross sections and nuclear species giving rise to the activities in the even elements have generally low abundance.

Thus far the pile analysis method has been developed and tested for the elements gallium and palladium. The method has been applied extensively to the problem of analyzing iron meteorites for these elements. Gallium is present in iron meteorites to an extent of 10 to 100 ppm; palladium is present to an extent of 1 to 5 ppm.

The Method Applied to Gallium. Gallium is present in sufficient quantity in meteorites, and the activation cross section is sufficiently large, to permit the use of the more modest neutron fluxes obtainable some distance from the center of the Argonne pile.

Gallium has two stable isotopes (*10*), Ga^{69} (60.2%) and Ga^{71} (39.8%). The more abundant isotope captures a neutron to form 20-min Ga^{70}; the less abundant isotope captures a neutron to form 14.1-hr Ga^{72}:

$$Ga^{69} + n \rightarrow Ga^{70} \xrightarrow{20m} Ga^{70} + \beta^-$$

$$Ga^{71} + n \rightarrow Ga^{72} \xrightarrow{14.1h} Ga^{72} + \beta^-$$

The radiation characteristics of the radioactive products are described elsewhere (*13*).

The samples were transported to a position near the reactor tank of the pile and out again by means of an electronically controlled pneumatic tube device known as a "rabbit," which has been described elsewhere (*9, 15*). Samples ranging in weight between 0.3 and 0.5 g were cut from portions of meteorites free from discernible inclusions of troilite, silicate, or schreibersite. The samples were washed with 6*N* hydrochloric acid, distilled water, and alcohol to remove surface impurities. The samples were then placed in individual small plastic containers in the rabbit and irradiated for approximately 30 min. Standard samples of gallium 8-hydroxyquinolate were irradiated simultaneously. After removal from the pile, the samples were allowed to cool until the 20-min gallium activity had decayed. The unknowns and the standards were then chemically treated. In the case of the unknowns, the chemical procedure was designed to make use of the fact that gallium is ether-extractable, as the chloride (*5*), is amphoteric, and can be precipitated as the 8-

hydroxyquinolate. The combination of these chemical properties permits development of a procedure which successfully frees the gallium activity from other interfering activities.

TABLE 2

SUMMARY OF RESULTS ON CANYON DIABLO

Run no.	Gallium content (ppm)	Δ Deviation from mean
6	77.4	0.0
7	79.0	1.6
10	76.2	1.2
12	74.6	2.8
13	84.2	6.8
14	78.0	0.6
17	70.0	7.4
18	76.2	1.2
19	79.2	1.8
20	82.0	4.6
21	80.4	3.0
149	76.8	0.6
152	75.2	2.2

Average : 77.4

Standard deviation $\sigma = \sqrt{\frac{\Sigma\Delta^2}{n-1}} = 3.4$ (4.4%)

Precision $= \frac{\sigma}{\sqrt{n}} = \pm 0.9$

Final result for 13 runs: 77.4 ± 0.9 ppm

TABLE 3

SUMMARY OF RESULTS ON HENBURY

Run no.	Gallium content (ppm)	Δ Deviation from mean
42	15.2	1.6
43	15.1	1.7
44	15.9	0.9
51	18.4	1.6
52	17.8	1.0
53	17.9	1.1
59	16.7	0.1
61	15.2	1.6
62	15.6	0.8
158	18.2	1.4
159	18.2	1.4

Average : 16.8

Standard deviation $\sigma = \sqrt{\frac{\Sigma\Delta^2}{n-1}} = 1.3$ (8.0%)

Precision $= \frac{\sigma}{\sqrt{n}} = \pm 0.4$

Final result for 11 runs: 16.8 ± 0.4 ppm

Chemical Procedure for Gallium in Iron Meteorites: 1) Dissolve sample in hot concentrated hydrochloric acid in 50-ml beaker. Add 4 to 5 mg of Ga^{+3} carrier. Decant solution from any insoluble residue present (seldom more than 0.1% by weight). 2) Make solution 5.5 to 6.5 M in hydrochloric acid. Extract gallium with an equal amount of ether saturated with hydrochloric acid. Extract gallium from ether phase with water. 3) Repeat step 2. Boil ether from water phase. 4) Add sodium hydroxide until solution possesses a hydroxide concentration of 1 to 2 M, precipitating all ferric ion present. This precipitate brings down with it residual interfering activities. Add one drop of aerosol, centrifuge, and discard the precipitate. Acidify the solution to a pH of 1.0 and heat to 60–70° C. 5) Add 5 ml of a 1% dilute acetic acid solution of 8-hydroxyquinoline. Add dropwise 3M ammonium acetate until the precipitation of yellow gallium 8-hydroxyquinolate is complete. 6) Filter and wash the precipitate with hot water, then ether. Determine the weight of the sample after heating at 110° C for 15 min. The sample is now ready to be counted.

TABLE 4

SUMMARY OF RESULTS ON ODESSA

Run no.	Gallium content (ppm)	Δ Deviation from mean
24	67.8	1.5
25	66.0	3.3
40	68.2	1.1
48	72.6	3.3
49	72.4	3.1
50	67.8	1.5
58	63.8	5.5
65	72.6	3.3
66	71.0	1.7
163	70.4	1.1

Average : 69.3

Standard deviation $\sigma = \sqrt{\frac{\Sigma\Delta^2}{n-1}} = 3.0$ (4.3%)

Precision $= \frac{\sigma}{\sqrt{n}} = \pm 0.9$

Final result for 10 runs: 69.3 ± 0.9 ppm

TABLE 5

SUMMARY OF RESULTS ON XIQUIPILCO

Run no.	Gallium content (ppm)	Δ Deviation from mean
26	56.2	1.0
27	51.4	3.8
28	59.3	4.1
32	53.0	2.2
33	54.6	0.6
34	54.8	0.4
35	53.0	2.2
36	54.2	1.0
37	51.6	3.6
146	65.0	9.8
155	54.5	0.7

Average : 55.2

Standard deviation $\sigma = \sqrt{\frac{\Sigma\Delta^2}{n-1}} = 3.9$ (7.1%)

Precision $= \frac{\sigma}{\sqrt{n}} = \pm 1.2$

Final result for 11 runs: 55.2 ± 1.2 ppm

Treatment of Gallium Standard. Samples contain-

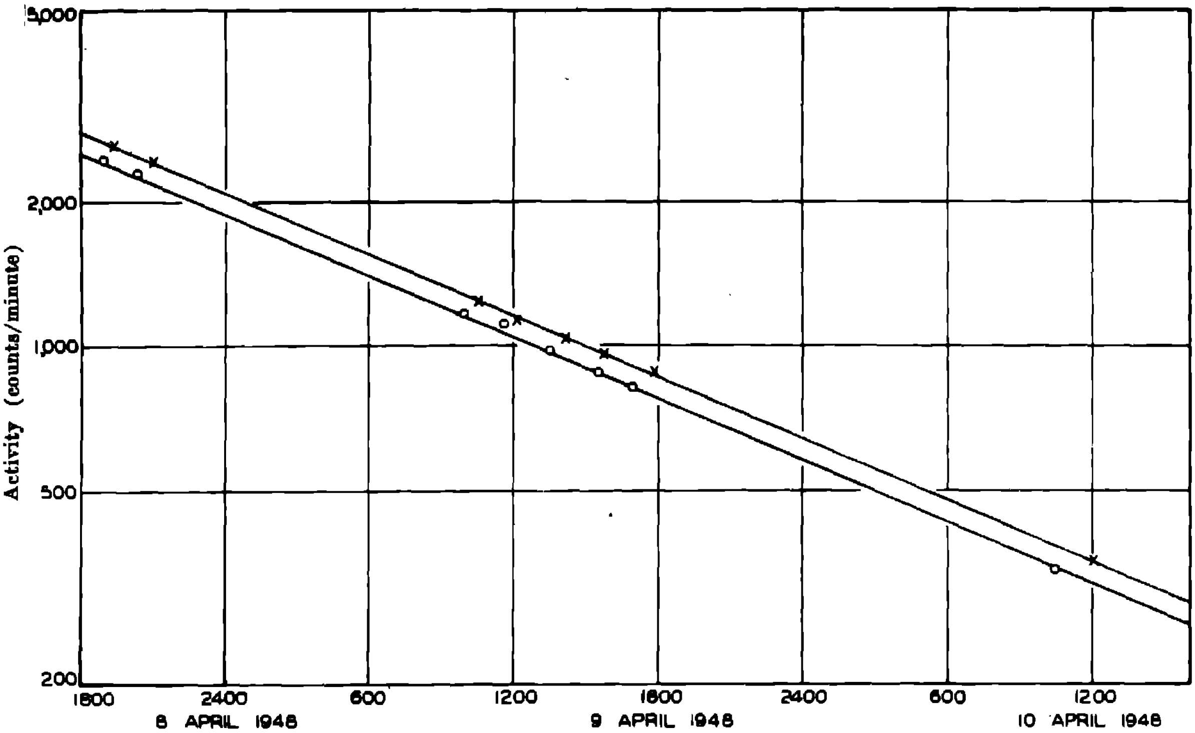

FIG. 1. Typical gallium decay curves. o Iron meteorite. × Standard.

ing approximately 10 mg of gallium 8-hydroxyquinolate were irradiated in containers identical with those used for samples of meteorites. The standards were dissolved in hot concentrated hydrochloric acid and diluted to 50 ml such that a 0.5-ml aliquot precipitated with gallium carrier as in the procedure above gave a dilution factor of 100 and the resulting precipitate had approximately the same counting rate as the gallium precipitate in the meteorite procedure.

Results. Extensive runs were made on four meteorites in order to ascertain the precision of the method. The results are shown in Tables 2, 3, 4, and 5. It will be noted that the standard deviation varies from 4.3% in the case of Odessa, where the gallium content is 69.3 ppm, to 8.0% in the case of Henbury, where the gallium content is 16.8 ppm. Such a drift of standard deviation with gallium content is to be expected under the conditions used, as all runs were made under nearly identical conditions of flux and irradiation time. Under such circumstances the counting rates for samples with low gallium content are lower than those with high gallium content. A marked increase of flux, irradiation time, or counting time would lower the standard deviation.

Figs. 1 and 2 show typical decay curves and aluminum absorption curves of standards and unknowns normalized to each other. Such data show that only gallium is being counted.

The results on Canyon Diablo, Henbury, Odessa, and Xiquipilco serve to show that the statistical errors involved in such a method of analysis are not prohibitively large. Runs were made on different days,

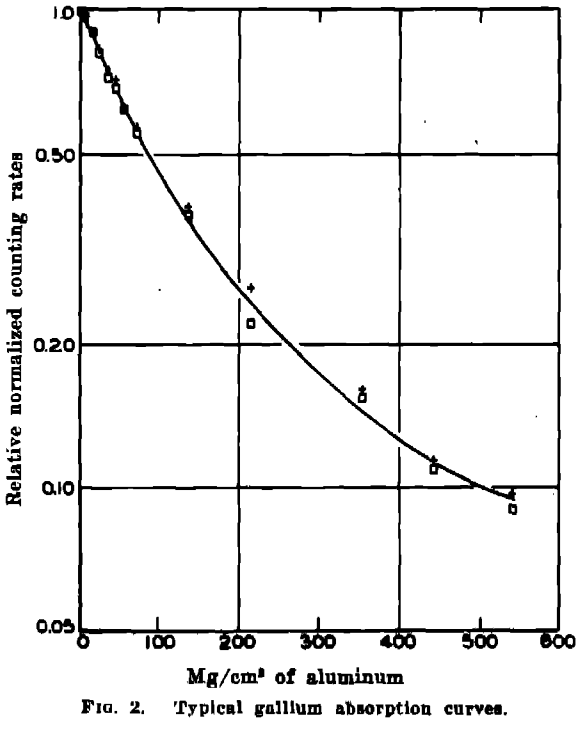

FIG. 2. Typical gallium absorption curves.

under varying conditions of neutron flux, location of samples in the rabbit, and irradiation time, and no constant drift of the results could be detected. However, if gallium in the form of room dust were being measured in addition to meteoritic gallium, a constant error would result. Consequently a number of substances were analyzed in order to ascertain whether or not the natural gallium contamination level was introducing errors. A sample of electrolytic iron, in which gallium could not be detected spectroscopically, was analyzed and found to contain 0.08 ppm of gallium. A sample of commercial aluminum was analyzed and found to contain less than 0.01 ppm of gallium. On the basis of these results, it seems safe to assume that no appreciable constant error due to gallium contamination was introduced in the measurements. The errors contributing to the standard deviation represent the sum of three effects: counting errors, actual deviations in gallium content from sample to sample (within a given meteorite), and actual errors involved in the chemical procedure.

TABLE 6

GALLIUM CONTENT OF VARIOUS IRON METEORITES

Name	Number of runs	Average gallium content (ppm)
Arispe	5	64.1
Canyon Diablo	13	77.4
Canyon Diablo #2	5	85.0
Carleton	3	11.2
Deport	8	61.4
Henbury	11	16.8
Mount Joy	4	47.5
Odessa	10	69.8
Sandia Mountains	6	53.2
Spearman	6	21.4
Tlaxcala	2	20.8
Xiquipilco	11	55.2
Institute of Meteoritics #2	3	21.1
" " " #6	3	90.5

A total of 14 iron meteorites were analyzed for gallium content. The results of the analyses are given in Table 6.

TABLE 7

SUMMARY OF PALLADIUM RESULTS ON CANYON DIABLO

Run no.	Palladium content (ppm)	Δ Deviation from mean
9	3.03	0.95
10	3.85	0.13
52	3.85	0.13
53	3.64	0.34
54	4.21	0.23
75	4.79	0.81
76	4.80	0.82
77	3.91	0.07
78	3.91	0.07
98	4.85	0.87
	Average: 3.98	

Standard deviation $\sigma = \sqrt{\frac{\Sigma\Delta^2}{n-1}} = 0.47$ (11.9%)

Precision $= \frac{\sigma}{\sqrt{n}} = \pm 0.15$

Final result for 10 runs: 3.98 ± 0.15

TABLE 8

SUMMARY OF PALLADIUM RESULTS ON HENBURY

Run no.	Palladium content (ppm)	Δ Deviation from mean
11	2.29	0.27
12	1.77	0.25
99	1.71	0.31
100	1.96	0.06
101	1.88	0.14
102	1.81	0.21
107	2.31	0.29
108	2.14	0.12
109	2.18	0.16
110	2.16	0.14
	Average: 2.02	

Standard deviation $\sigma = \sqrt{\frac{\Sigma\Delta^2}{n-1}} = 0.22$ (10.9%)

Precision $= \frac{\sigma}{\sqrt{n}} = \pm 0.07$

Final result for 10 runs: 2.02 ± 0.07 ppm

The Method Applied to Palladium. Palladium exists in iron meteorites to an extent of about 1 to 5 ppm. Activities obtainable in the rabbit were too low to permit the accumulation of precise enough data, and so all runs were made in the center of the pile, using irradiation times of approximately 1 hr. The element yields two prominent activities upon irradiation with slow neutrons, one of half-life 13 hr produced from Pd^{108} and one of half-life 26 min produced from Pd^{110}. The two isotopes giving rise to the activities have abundances of 26.8% and 13.5% re-

TABLE 9

SUMMARY OF PALLADIUM RESULTS ON ODESSA

Run no.	Palladium content (ppm)	Δ Deviation from mean
95	4.16	0.01
96	4.01	0.14
97	3.52	0.63
103	4.06	0.09
104	3.64	0.40
111	4.12	0.03
112	4.06	0.09
113	4.22	0.07
114	5.04	0.89
115	4.64	0.49
	Average: 4.15	

Standard deviation $\sigma = \sqrt{\frac{\Sigma\Delta^2}{n-1}} = 0.45$ (10.81%)

Precision $= \frac{\sigma}{\sqrt{n}} = \pm 0.14$

Final result for 10 runs: 4.15 ± 0.14

spectively (*13*). The radiation characteristics of the two activities are discussed elsewhere (*13*).

TABLE 10

SUMMARY OF PALLADIUM RESULTS ON XIQUIPILCO

Run no.	Palladium content (ppm)	Δ Deviation from mean
36	4.52	0.20
37	4.18	0.56
38	4.14	0.58
49	5.37	0.35
50	4.59	0.19
51	4.74	0.02
86	5.21	0.49
87	4.85	0.13
88	4.87	0.15
89	4.73	0.01

Average: 4.72

Standard deviation $\sigma = \sqrt{\frac{\Sigma\Delta^2}{n-1}} = 0.31$ (6.6%)

Precision $= \frac{\sigma}{\sqrt{n}} = \pm 0.10$

Final result for 10 runs: 4.72 ± 0.10

Samples of iron meteorite each weighing approximately 0.3–0.5 g were irradiated in soft glass vials, together with a standard of palladium dimethyl glyoxime. After irradiation the samples were permitted to cool until the 26-min activity had died away. The samples were then chemically processed. The chemical procedure used for the isolation of the palladium activity was a modification of a procedure developed by Seiler (*14*). Use was made of the fact that palladium can be precipitated as the dimethyl glyoxime, and that it also forms a complex in excess ammonium hydroxide.

TABLE 11

PALLADIUM CONTENT OF VARIOUS IRON METEORITES

Name	Number of runs	Average palladium content (ppm)
Arispe	4	2.09
Canyon Diablo	10	3.98
Canyon Diablo #2	3	5.30
Carleton	4	6.52
Deport	8	4.45
Henbury	10	2.02
Institute of Meteoritics #2	3	2.82
" " " #6	5	4.46
Mount Joy	3	3.30
Odessa	10	4.15
Sandia Mountains	3	2.24
Spearman	3	3.07
Tlaxcala	4	2.29
Willow Creek	3	3.70
Xiquipilco	10	4.72

Chemical Procedure for Palladium in Iron Meteorites: 1) Dissolve the sample of irradiated meteorite in hot concentrated hydrochloric acid in a 50-ml centrifuge tube covered with a watch glass. Add 10 mg of Pd^{+2} carrier. Keep tube in ice bath in order to inhibit oxidation of Fe^{+2}. (Palladium dimethyl glyoxime will not precipitate easily in the presence of Fe^{+3}.) 2) Add ammonium hydroxide until solution is 0.4 M in acid. Add 3–5 ml of 1% dimethyl glyoxime solution. Allow solution to stand 40 min.

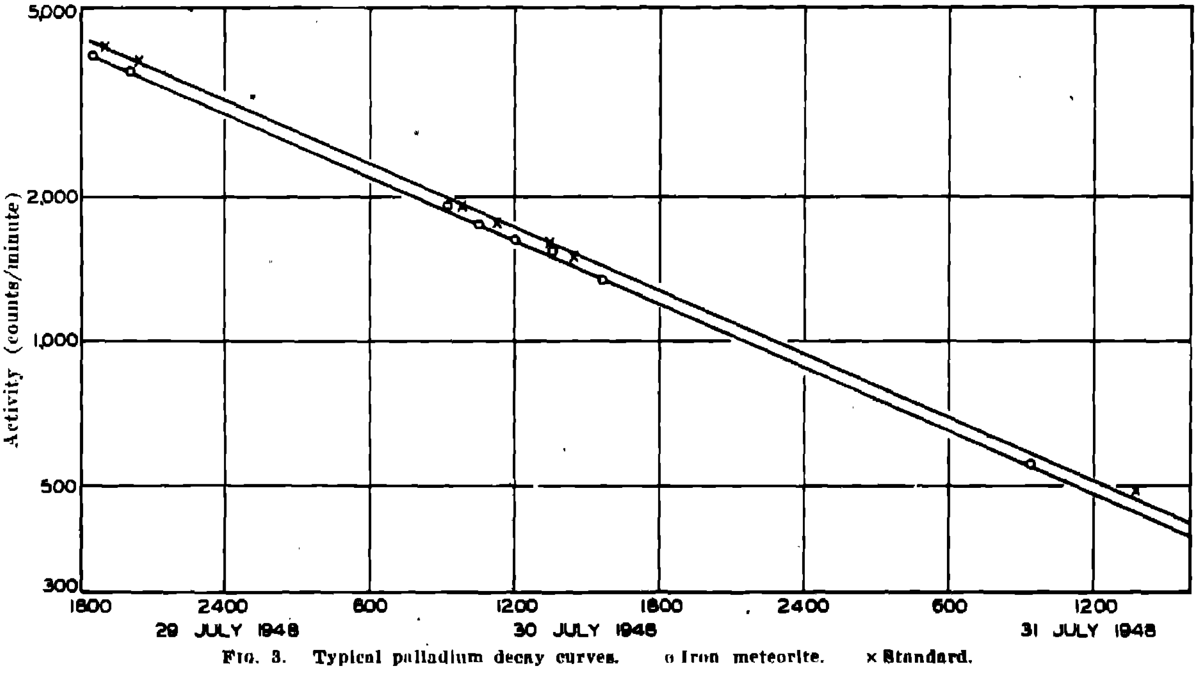

FIG. 3. Typical palladium decay curves. o Iron meteorite. x Standard.

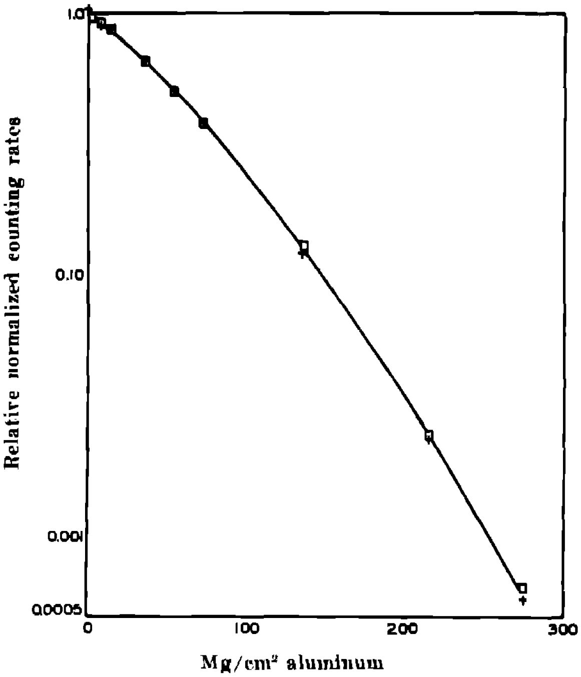

FIG. 4. Typical palladium absorption curves. □Iron meteorite. + Standard.

Centrifuge. 3) Dissolve precipitate in 1 ml of hot concentrated nitric acid. Cool and dilute with 10 ml of water. Add 5 mg of Fe^{+3} carrier. Add excess ammonium hydroxide to precipitate iron. (This step removes a number of extraneous activities.) Add 10 mg of Ag^+ carrier and enough iodide to precipitate all silver. (This step removes any silver activity present.) 4) Centrifuge and discard the precipitate. 5) Repeat steps 3 and 4. 6) Adjust acidity to 0.4 M. Centrifuge solution to remove any silver chloride precipitate formed. 7) Add 3–5 ml of 1% dimethyl glyoxime solution and allow solution to stand 40 min. Filter. 8) Wash the precipitate with first hot and then cold water and ethyl alcohol. Determine the weight of the sample after heating at 110° C for 10 min. The sample is now ready to count.

Treatment of Palladium Standard. Samples containing approximately 10 mg each of palladium dimethyl glyoxime were irradiated in containers identical with those used for meteorite samples. Each standard was then dissolved in hot concentrated nitric acid and diluted to 500 ml such that a 0.5-ml aliquot, when precipitated with the standard carrier aliquot, gave a dilution factor of 1 part per 1,000 and approximately the same counting rate as the palladium from the meteorite.

Results. In order to estimate the reproducibility and precision of the palladium procedure, as in the case of gallium, a number of runs were made on four meteorites. The results are shown in Tables 7, 8, 9, and 10. It will be noted that the standard deviations obtained are quite satisfactory. Table 11 gives the palladium contents of 15 iron meteorites. Figs. 3 and 4 show typical palladium decay curves and aluminum absorption curves.

Thus, the neutron pile as a tool in quantitative analysis is quite generally applicable and is particularly useful in analyzing unknowns for minor constituents. In applying the method to the problem of analyzing for minute concentrations of gallium and palladium in iron meteorites we found that the procedures gave consistent results, with low standard deviations from the mean. The procedures are not complicated, are free from interferences from other elements, and are also free from the danger of contamination during the course of the analysis.

Adapted from a paper presented at the Symposium on Nuclear Reactions held by the Division of Physical and Inorganic Chemistry of the American Chemical Society at Portland, Oregon on September 16, 1948. Submitted for declassification on August 16, 1948. Taken in part from a doctoral thesis to be submitted by Edward Goldberg to the faculty of the University of Chicago in partial fulfillment of requirements for the degree of doctor of philosophy.

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Seven Decades of Nutrition Research

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THE HUNDRED YEARS since the founding of the American Association for the Advancement of Science have been one of the most interesting half-centuries in the history of the world. In most fields of science the advances made during this period far overshadow the developments in any previous century. However, it is always valuable to review the early foundations upon which our modern science is built. Even in the field of nutrition, which is considered a 20th century development, we find many phases of it deeply rooted in the science of previous centuries.

There is no specific reason for starting my survey about 1880, although I was probably influenced by the statement in Richard O. Cumming's book, *The American and his food,* namely, "Few Americans thought about the chemical composition of foods before the last quarter of the Nineteenth Century. The diet reformers of the thirties had stressed the advantages of eating food in a condition approximating its natural state, but they were not analysts and had had little scientific data to substantiate their claims. Their teachings were largely forgotten by the eighties, though the word 'Graham' was still used to designate unbolted wheat flour."

Before proceeding to the laboratory developments of nutrition, I want to mention other factors which had much to do with the improved quality of food for the American people. For example, the availability of fresh foods, especially milk and meat, in cities, greatly increased upon construction of our railroads. Although the work of Koch and Pasteur, which indicated that every disease must have a positive causative agent, tended to retard the recognition of positive nutritional factors, the safeguarding of fresh foods from bacterial contamination, which became possible as a result of the early work in bacteriology, did much to improve nutrition in this country. Improved agricultural production also meant more food, but misguided attempts to purify our food products tended to overcome many of the advantages of increased production. The wheat bran and the meat scraps made better pigs and chickens, but the refined flour and the diversion of liver into animal feeds made poorer human beings.

Organized investigations in nutrition originated largely on the European continent and most of the work was closely allied with physiology. Voit at Munich initiated studies on the value of proteins but soon turned his attention to energy requirements. These studies were continued by Rubner in Berlin. In this country during the decade 1880–1890 Armsby, who had studied in Germany, carried on experimental work in animal nutrition and calorimetry at Yale, Wisconsin, and Pennsylvania. During the same period Chittenden started at Yale his work on digestion and metabolism, which continued until his retirement in 1922. In 1887, when the American Physiological Society was created, Chittenden was the only member who had a true interest in nutrition. Thus the contributions during the first decade were meager, but we must not overlook the fact that many of the Agricultural Experiment Stations were organized during this decade after the Hatch Act of 1887 and that much valuable nutritional work has come from these stations. When Babcock came to Wisconsin in 1887 he was convinced that other nutrients in foods besides carbohydrates, fats, proteins, and minerals were important.

The most important event during the second decade of our story, 1890 to 1900, is undoubtedly the work of Eijkman. On the basis of systematic experiments he was able to refute the theories that beri-beri might be due to the presence of pathogenic organisms in rice, to lack of mechanical stimulation of the intestine, or to insufficiency of total food. He suggested that beriberi is a state of intoxication brought about by the metabolism of excessive quantities of starch and that the silver skin of the rice contains a substance which counteracts the toxic products of the disturbed metabolism. The conception of a positive factor in rice polishings, indispensable to health, did not develop until the following decade.

We are probably safe in concluding that no scientific studies on vitamins were conducted in the United States before the 20th century. However, during this last decade of the 19th century, Congress appropriated $10,000 for the year ending June 30, 1895 and $15,000 the following year to enable the Secretary of Agriculture "to investigate and report upon the nutritive value of the various articles and commodities used for human food." Atwater was placed in charge of nutrition investigations, and in 1896 Atwater and Woods published an extensive compilation on the proximate analysis of American food materials. This bulletin (No. 28) has been a standard reference on food composition, and tables in many text books are based on these early values.

The next decade, or the first period in the new century, can be characterized by a growing interest in biochemistry. The American Society of Biological Chemists was organized in 1906 and both the *Journal of biological Chemistry* and the *Biochemical Journal* were started during the first part of the century. Lusk, an active member in the Society, continued to emphasize the importance of energy metabolism in both health and disease. Levine started his important work on nucleic acids and their breakdown products which are assuming such importance in nutrition at the present time. Folin and Benedict developed methods which could be utilized in studies on protein metabolism. The importance of amino acids, the constituents of proteins, in nutrition was being given consideration by Osborne and Mendel in this country, and Hopkins in England. Sherman, during his connections with the U. S. Department of Agriculture, established the early requirements for calcium, iron, and phosphorus in the human body. All of this work provided a sound foundation for future studies but did not stimulate any great interest in nutrition as such. The original Federal Food and Drug Act was passed during this period but the evolution of the law, which took place over a period of 25 years, was based largely on chemical analysis. Greatest emphasis was placed on adulteration of foods and drugs which could be recognized chemically. A few workers were beginning to recognize that true nutritional value of foods could be determined only by animal experimentation. The work of Eijkman was not too well known in this country, but Babcock and Hart were experimenting with calves on rations compounded according to available feeding standards.

The next decade, 1910–1920, brought an entirely new point of view. It was found that calves failed to grow on rations made entirely from products of the wheat plant but thrived on rations made from the corn plant. Hopkins obtained a very significant growth response in rats fed purified rations when a few cc of milk were added. The work of Osborne and Mendel, and McCollum and Davis showed that rats fed purified rations developed normally when the fats of the diet consisted largely of butter fat but failed when other fats, now known to be low in vitamin A, were used. Chicks grew normally if allowed access to sunlight shortly after hatching but developed severe leg weaknesses when they were hatched early in the spring. It was in 1914 that the Pellagra Commission reported that "Pellagra is in all probability a specific infectious disease communicable from person to person by means at present unknown" and that the Surgeon General of the U. S. Public Health Service ordered Dr. Goldberger to take charge of the pellagra investigations. Shortly thereafter, he produced typical pellagra in prison volunteers in Mississippi by placing them on a restricted diet, and also observed the development of blacktongue in dogs fed similar rations. During the first part of this period, Funk isolated a crystalline compound from concentrates which were active in the prevention of polyneuritis in pigeons. The substance which he actually isolated was nicotinic acid, which was later shown to be the antipellagra factor.

By the end of this decade, at least three separate vitamins were recognized as essential for the growth of young, and evidence was available which indicated that there might be additional vitamins. The real significance of these factors in total metabolism was unknown. With the outbreak of the first World War, attempts were made to utilize the limited knowledge available by advocating greater use of the so-called protective foods. This, together with the dramatic responses obtained upon supplying these foods when deficiencies occurred, led to the popularization of vitamins, which developed tremendously the next decade.

The period between 1920 and 1930 represents a transition stage between the early unstandardized animal studies and the more effective approach as a result of the greater interest which biochemists and organic chemists took in this field. By 1925 many laboratories were undertaking systematic nutrition studies, and fairly quantitative assay procedures were developed for the known vitamins. Even with these improved techniques and the use of more highly purified basal rations, many of the B vitamins were not recognized until the following decade, and apparently we still have some to look for. The relation of vitamin D to ultraviolet light was established in 1924, and this stimulated work on the chemical structure of sterols. The early recognition of the relationship of vitamin A to carotenoids stimulated studies on the structure of the carotenes, but the exact relationship was not established until 1929. Small amounts of crystalline vitamin B_1 were isolated in 1926, and in 1927 Szent-Gyorgi isolated a crystalline compound which King and co-workers later found to have antiscorbutic activity. Before leaving this period, it is important to mention that the American Institute of Nutrition was organized in 1928. This society brought together a group of workers trained in many fields but with one common interest, and it also tended to balance the different phases of nutrition research.

The fourth decade of this century will undoubtedly be recognized as the period in history when greatest progress was made in the chemistry of vitamins and other essential nutrients. Work on the isolation, characterization, and synthesis of vitamins has attracted the attention of many of the outstanding chemists in the world. The decrease in the wholesale price of most of the vitamins during the past 10 to 12 years is well known to all of us. It is needless to mention the significance, not only in nutrition but in all metabolic work, of the availability of sufficient quantities of these interesting chemical compounds to make their use unlimited. We are still looking for some of the new vitamins and as a new one becomes available progress accelerates in all phases of nutrition.

It was also in this decade that we began to study and appreciate the mechanisms through which the vitamins function in the living cell. In 1931 Peters, in England, showed that the brain tissue of thiamine-deficient pigeons was incapable of oxidizing glucose at a normal rate. This observation was soon followed by the demonstration that *in vitro* addition of thiamine to deficient brain tissue resulted in an increased rate of respiration. So today we think of thiamine in relation to the coenzyme decarboxylase, which is necessary in the metabolism of α keto acids, and of nicotinamide and riboflavin as necessary for the formation of enzyme systems which function in the transport of electrons during the oxidation of all types of foodstuffs. We think of the B_6 vitamins in relation to the metabolism of amino acids and pantothenic acid as a constituent of the coenzyme required for acetylations. Very recently it has been shown that one of the functions of biotin relates to the fixation of carbon dioxide with pyruvate to form oxalacetate. This relationship between vitamins and the prosthetic groups in enzymes makes it easy to understand the body's continuous requirement for vitamins, and the reason why vitamin requirement may vary, depending upon composition of the diet.

Furthermore, workers began to recognize the relation of vitamins to the growth factors for bacteria. The importance of riboflavin in the animal was recognized in 1933, and the need of this compound for the growth of lactic acid bacteria was shown in 1936. In 1937, nicotinic acid was shown to be important for both animals and microorganisms. Williams first recognized pantothenic acid as a growth factor for yeast in 1933; in 1939 this compound was shown to be the chick antidermatitis factor. Similar relationships were shown for pyridoxine, biotin, and inositol.

These studies led to the use of bacteria for the quantitative estimation of vitamins, and the first widely used method was that proposed by Snell and Strong in 1939 for riboflavin by means of *Lactobacillus casei*. However, extensive use of this and related methods did not take place until later.

The present decade has been most interesting to many of us. In the first place, we have seen the practical application of scientific knowledge to an extent which surpassed the hopes of the most enthusiastic workers. In November 1940 a committee, which later became the Food and Nutrition Board, was called together by the National Research Council to mobilize available knowledge of nutrition for the guidance of the several agencies of the Government which were facing problems involving food and nutrition. This group recognized immediately that if plans were to be made for securing optimum nutrition for either military or civilian groups, uniform values for human requirements must be established. The Board called upon everyone who had given any thought to this problem; and the dietary allowances, which are now so familiar, were first submitted to the National Nutrition Conference for Defense in May, 1941. These values have undergone several revisions and the new 1948 edition will soon be available.

In the words of Dr. Jeans "The allowances have potentialities for innumerable applications. Throughout the war they served as standards for the diets of our military forces throughout the world. The allowances are useful in making dietary surveys, in assessing the needs of our civilian population and as a guide in feeding population groups. They have been widely used as guides for family buying for welfare administration. They have been used as a basis in determining production goals. They serve as a focal point for guiding research that is to fill those gaps in our knowledge which are evident from a review of the derivation of the allowances."

It was also obvious that figures for dietary requirements were of little value unless the composition of the food products consumed was known with considerable accuracy. The need for such information became very critical during the war and in 1942 the Office of the Quartermaster General requested the Food and Nutrition Board to assemble, coordinate, and appraise the available data on food composition. The extensive tables resulting from these studies were finally published as U.S.D.A. Miscellaneous Publication No. 572. Work on the preparation of such tables did much to stimulate interest in the improvement and simplification of the assays for all the essential nutrients. As chemical and microbiological methods replaced animal assays, more and more evidence accumulated to show that many nutrients may be present in several different forms. For example, vitamin B_6 activity in foods may be due to the presence of pyridoxine, pyridoxal, or pyridoxamine. This merely emphasizes the complexity of biological material and the problems encountered when attempts are made to place nutrition on a truly quantitative basis. The food industries and food processors have recognized this problem and have done much to support and stimulate work on food composition. This is important from their point of view since they must know the possible changes in nutritional value of foods during processing and cooking. Each nutrient and each of its different forms may be affected differently.

From these studies has come the interesting observation that often the availability of certain nutrients in natural foods may be improved by a proper degree of processing. Furthermore, natural foods can be improved by combining two incomplete food products or by adding minerals, synthetic vitamins, and even amino acids.

In an effort to bring national nutrition to the suggested levels of the allowances, the Food and Nutrition Board has recognized the desirability of limited types of food fortification. These include iodized salt; the addition of vitamin D to milk; the enrichment of flour, bread, and certain cereals with B vitamins and minerals; and the fortification of margarine with vitamin A. In applying these new scientific developments great care must be taken to control their use and to prevent the indiscriminate use of synthetic products to the detriment of the public. I believe the Council on Foods and Nutrition of the American Medical Association has made the most acceptable statement regarding fortification.

The Council wishes to encourage efforts to improve as far as possible the nutritive quality of all foods which contribute importantly to the American diet and which thereby constitute the food environment of the people. In spite of all these efforts there exists now and will undoubtedly continue to exist for some time, certain specific deficiencies in large segments of the population which can be remedied best through addition of indicated nutrients to cheap, staple foods that occupy substantial places in the dietary. The Council has favored and encouraged the addition of certain nutrients to selected foods for the purpose of overcoming these deficiencies by replacing as nearly as possible that which has been lost in processing, or by making appropriate foods serve as carriers of dietary essentials which are inadequately supplied by many diets. In any case, the purpose of adding synthetics to natural foods should be to prevent known deficiencies in groups of the population and not to use synthetic products which happen to be available at low cost.

The Council disapproves of unlimited or indiscriminate fortification of general purpose foods with minerals, vitamins, amino acids, or other nutrients.

Although fortification is largely a product of the present decade, it is important to mention that the addition of vitamin D to milk was initiated in 1928, and the program has now been in progress long enough to demonstrate its true value. The incidence of rickets in the children of this country is almost nil. Iodized salt was introduced still earlier but due to the absence of controlled procedures, the program has not been so successful.

The improved methods which have been used for the analysis of food have also been applied in metabolic studies especially in carrying out balance studies and saturation tests. These procedures have done much to improve the diagnosis of early nutritional deficiencies. They have also stimulated direct studies on human subjects. For example, studies at the Elgin State Hospital have been in progress several years to determine possible variations in the thiamine and riboflavin requirements between young and old subjects.

Another great development, which will be given more and more recognition with time, was the establishment of the Food and Agriculture Organization of the United Nations, and the recognition that human nutritional needs can only be satisfied through a sound food policy which is not only national but international. It is most gratifying that these applications of science have not detracted from fundamental studies. For example, much of the work on isolation, characterization, and synthesis of folic acid was done during the war period. The availability of folic acid makes it possible to continue the search for remaining members of the vitamin B complex. Although folic acid may not be directly concerned with pernicious anemia, the work on folic acid led to the final isolation of vitamin B_{12}, which appears to be the true pernicious anemia factor. In other words, these studies clear up problems which were initiated two decades ago, when Minot and Murphy found liver and liver extract to be effective in pernicious anemia.

It is also apparent that some of the newer nutritional factors are active in extremely small quantities. For example two to five micrograms of vitamin B_{12} are sufficient to give a very significant hematopoietic response in pernicious anemia. The daily requirement for the human is probably much less. This brings us to another very interesting development which has taken place largely during the present decade, namely the significance of the intestinal microflora in nutrition. I cannot help but refer to the first experiment conducted in our laboratory back in 1940, when it was shown that the feeding of sulfaguanidine reduced the growth rate of rats and that this retardation could be overcome with liver preparations, because many of my co-workers were skeptical when I explained the results on the basis of retarded intestinal synthesis of unknown B vitamins. Today we recognize the importance of intestinal synthesis of vitamins and possibly other nutrients not only in animal experiments but in human nutrition. Emphasis is being placed on the relation of intestinal flora to conditioned deficiency diseases in man.

It will not be possible for me to give any extensive review of the many important fundamental problems now under investigation, but I shall mention a few.

The studies on amino acids initiated 40 years ago are now being brought to successful conclusion. Rose has made extensive studies with humans to determine the quantitative requirements of adults. Cannon has also shown that the recognized essential amino acids may suffice for the maintenance of nitrogen equilibrium in adult rats. However, recent work in our laboratory with the growing animal indicates that many of the nonessential amino acids also need to be added for optimum growth. Very recently we have secured growth in mice equal to that obtained with intact protein by supplying all the amino acids in free form.

Another problem is the interrelationship between various nutrients—the most interesting of which is the interrelationship between niacin and tryptophan. This has led to the complete understanding of the early work of Goldberger during the second decade of this century. Today we know definitely that pellagra is associated with corn consumption not only because it is low in niacin but also because the protein in corn, zein, is low in the amino acid tryptophan.

One of the most interesting developments during this decade has been the recognition of metabolic antagonists. The availability of many of the nutrients in pure and synthetic form has allowed modification in the structure of these compounds. Out of this work has come the general recognition that slight modifications in the structure of certain vitamins may change them from essential nutrients to detrimental metabolites. Although these observations may not have direct application to nutrition, because few of the antagonists occur in nature, these relationships will give much information regarding metabolism.

All of this work emphasizes the importance of recognizing all the nutrients taken in by living cells, whether they be present in animals, plants, or microorganisms. These nutrients may not always be essential, but they may become important under certain environmental conditions. There is great hope for the future in nutrition, if we recognize this broad principle, and if we continue to develop techniques which will measure some of the nutrients which are active in the minutest quantities. During the past few decades, we have developed from a point where we thought milligram quantities were important to a point where we must recognize microgram and millimicrogram quantities. If we can supply these substances in optimum amounts and in the proper ratios we will have an efficient machine for the utilization of energy for growth and development, or in other words, we will have optimum health. In spite of the tremendous advances in the science of nutrition and in food technology, our world food problem today is still one of total calories. On the other hand, in areas like the United States where caloric undernutrition has been relatively rare for many years, there appears to be some correlation between the increased incidence of degenerative diseases and high caloric intake, and efforts are under way to control food intake at least to a limited extent.

We can therefore look back on seven decades of nutrition research with considerable satisfaction. Enthusiasm over newly discovered nutrients may have given too great emphasis to certain phases of nutrition for short periods of time, but active workers soon reinstituted the proper balance. Workers in nutrition have made use of the scientific advances in many of the related fields, and at the same time have contributed to the advances in allied fields; but in doing so they have not diverged too far from the main goal of optimum health for all.

Based upon an address presented at the Symposium on Food and Nutrition, American Association for the Advancement of Science, Washington, D. C., September 16, 1948.

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TECHNICAL PAPERS

The Prevention and Treatment of Motion Sickness I. Seasickness[1]

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During the year 1947, Dramamine (β-dimethylaminoethyl benzohydryl ether 8-chlorotheophyllinate) was sent by the manufacturer to the Allergy Clinic of the Johns Hopkins University and Hospital for experimental investigation of its value in the control of the symptoms of hay fever and urticaria. The drug was administered to a pregnant woman who complained of urticaria and who incidentally has suffered all her life from car sickness. Unexpectedly, the car sickness was relieved as well as the urticaria. It was possible to control the car sickness of this patient at will. A placebo failed repeatedly, but the drug Dramamine gave her complete relief if she took 50 mg a few minutes before she boarded the streetcar.

A study of seasickness was planned and executed on the U. S. A. T. "General Ballou." This transport carried 1,366 soldiers to Bremerhaven, Germany. The voyage began on November 27, 1948 and, after a rough passage, terminated on December 7, 1948. Complete cooperation was given by the Surgeon General's office and by the Transport Command. Four adjacent compartments on the transport were set aside for the controlled study of the 485 men who were assigned to them and subjected to the same motion of the sea. Treatment was planned so that half the men were given Dramamine or a placebo of lactose at the time of departure from New York Harbor; the other half were given Dramamine or a placebo 2–12 hr after the onset of symptoms of seasickness. Adequate control groups were given a placebo. The dose of Dramamine was 100 mg every 5 hr and before retiring. Dramamine prevented seasickness in all but two of the 134 men who occupied compartment 3-E; a placebo failed to relieve the symptoms in all controls who developed true seasickness in compartment 3-F. However, the control group (34 men) obtained complete relief of symptoms within 1 hr after the first dose of Dramamine was administered. The drug gave complete relief to 14 men in compartment 4-E who developed symptoms 3 hr or more after the transport left New York. A placebo failed to relieve 14 men in compartment 4-F, but these men obtained complete relief ½ hr after Dramamine was substituted for a placebo. Nineteen men who developed symptoms (nausea and dizziness) 3 hr or more after the transport left New York were relieved by a placebo. These men required no medication during the last seven days of the voyage to Bremerhaven. Among 881 men who occupied other compartments on the transport, 195 cases of severe seasickness developed. Of these, 187 derived complete relief ½ hr after the administration of Dramamine. Relapses were induced by the substitution of a placebo, but these symptoms were relieved within ½ hr after the administration of Dramamine. During a period of 10 days, Dramamine was given to 389 cases of seasickness. Of this number, 372 were completely relieved of symptoms within 1 hr after the first dose of 100 mg. Seventeen cases derived only partial or no relief. A dose of 100 mg prescribed every 5 hr and before retiring was adequate to control the most distressing symptoms. When the patient was unable to retain a capsule administered orally, he did retain and absorb the drug given rectally. The benefit derived by this method was as rapid and as complete as that derived by the oral method. No reaction to Dramamine was encountered by any soldier to whom it was administered during the period of 10 days.

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[1] This investigation was made possible by the Chief of Staff and the Surgeon General of the United States Army.

[2] The authors wish to express their appreciation to the Transport Command, especially Major C. W. Hodges, Lt. J. L. Soelling, and the nurses of the U. S. A. T. "General Ballou"; and to G. D. Searle & Co., of Chicago, who prepared the Dramamine and the placebo for the investigation.

The Effectiveness of Dramamine in the Prevention of Airsickness

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The recent report by Gay and Carliner (*2*) on the effect of the new antihistaminic drug, Dramamine (β-dimethylaminoethyl benzohydryl ether 8-chlorotheophyllinate), as a preventive and treatment for seasickness has attracted widespread attention. Investigations on motion sickness in the past have shown a paucity of controlled studies carried out on shipboard or on aircraft. The methodology utilized by Gay and Carliner is strikingly provocative in that practical studies on motion sickness under actual precipitating conditions were subjected to controlled scientific scrutiny.

Armstrong (*1*) has pointed out the dearth of comprehensive reports in the literature on the subject of motion sickness caused by aircraft in flight. This form of motion sickness is well known and is encountered often enough to be considered a major problem of aviation medicine. Air sickness is one of the most frequent causes of distress among airline passengers. In military aviation an appreciable number of flying cadets are eliminated for this reason; it is not unusual for combat aircrews to be affected; and not infrequently a high percentage of airborne troops and paratroopers are more or less incapacitated by the time they have reached their destination.

Smith (*3*) in 1946 reviewed all of the previous work aimed at finding a motion sickness remedy and recommended that until a better drug was available hyoscine hydrobromide be used in the prevention of airsickness in Air Force personnel. The reported remarkable effectiveness of Dramamine (*2*) in the prevention and treatment of seasickness would indicate that this drug might also be valuable in airsickness and in February 1949 the Air Surgeon authorized the USAF School of Aviation Medicine, Randolph Air Force Base, Randolph Field, Texas, to initiate tests.

A preliminary controlled study has been completed. A procedure was devised whereby one-hour flights simulating flight through turbulent air in a C-47 (DC-3) airplane were utilized. Volunteers were obtained from among individuals stationed at Randolph Air Force Base who were not on flying duty. No other selection factors were utilized within this group since it was desired to have as a test group a cross-section of young adult males who had not become conditioned or adapted to aircraft motion. In view of this it can be considered that the individuals studied are similar to those studied by Gay and Carliner.

Twelve flights of 18 individuals each have been carried out to date. On each flight conditions encountered in flying through gentle and moderately turbulent air were simulated. All variable factors were either controlled or "randomized." Methodology was as follows:

(a) Each group of 18 men on a flight was subdivided into a group of nine who received a 100-mg tablet of Dramamine and another nine who received a placebo identical in appearance. Care was taken to prevent each individual from knowing whether he received drug or placebo.

(b) The drug or the placebo was administered concurrently from 25 to 45 min before each flight.

(c) Seating arrangement in the airplane was carefully controlled in that an equal number of individuals who received the drug were distributed symmetrically in the forepart and the afterpart of the cabin. The same procedure was used in seating the individuals who received the placebo. In addition, drug and placebo subjects were symmetrically distributed on the right and left sides of the cabin.

(d) All flights were made at an altitude of 5,000 feet above mean sea level. The pilots had previously developed methods of simulating flight through gentle and moderately turbulent air. These maneuvers may be summarized as follows: (1) Yawing or "fish-tailing"—produced by moving the rudder from side to side. (2) Rolling—produced by raising and lowering the wings alternately by the aileron controls. (3) Pitching (including ascending)—produced by moving the elevators causing up-and-down motion. Minor altitude variations were obtained similar to those caused by updrafts and downdrafts. (4) Various combinations of the foregoing maneuvers were used and approximately three-fourths of the duration of each flight was devoted to intermittent simulation of flight through turbulent air.

(e) As in previous studies carried out on motion sickness at the School of Aviation Medicine, the incidence of airsickness in the subjects was judged on a purely objective basis, i.e., whether or not vomiting occurred.

Twelve flights were made under the conditions described and a total of 216 subjects were tested. One-half of the subjects received Dramamine and the other half a placebo. The results are shown in Table 1.

TABLE 1

Preflight medication	Airsick		Not sick		Total number
	Number	Percentage	Number	Percentage	
Dramamine . .	31	28.7	77	71.3	108
Placebo	60	55.6	48	44.4	108

Under the conditions described above 28.7 percent of those given Dramamine became ill as opposed to 55.6 percent among those given a placebo. Application of the statistical technique known as sequential analysis to the results shown in Table 1 indicates that additional experimental flights as described above would result merely in further verification of the same relative difference of incidence of airsickness.

So important is the solution of the problem of motion sickness in both commercial and military aviation that any drug or type of drug which appears to have significant effects in preventing airsickness warrants extensive investigation. Although the results of this experimental study are not spectacular, Dramamine appears to decrease the incidence of airsickness. More exhaustive studies under actual turbulent conditions are indicated. Additional research is presently under way at the USAF School of Aviation Medicine concerning the mechanism of action of Dramamine and other drugs in the prevention and treatment of airsickness.

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Chronic Toxicity of Gossypol[1]

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The widespread publicity attained by gossypol as an appetite depressant, since the report (*3*) that highly purified preparations of gossypol act by delaying the passage of food from the stomach to the duodenum in the rat, has led to repeated requests for the use of this material for clinical trial in the treatment and control of obesity. Gossypol, a polyphenolic yellow pigment, is the principal component found in the pigment glands of cottonseed (*1*). Its acute oral toxicity and that of cottonseed pigment glands for rats, mice, rabbits, and guinea pigs have been reported (*2*).

To determine the effects of repeated oral doses of gossypol on the food intake and body weight, four young, litter-mate male dogs (5.0 to 5.4 kg) were given daily doses of 0, 50, 100 and 200 mg/kg body wt of the material, respectively, during three different experimental periods according to the following schedule: 55-day control period, 5-day experimental period (gossypol by capsule), 9-day control (rest) period, 5-day experimental period (gossypol by stomach tube), 9-day control period, 9-day experimental period (gossypol by stomach tube). From the first administration to the last, each of the three experimental dogs received a total of 19 daily doses of gossypol within a period of 37 days, which resulted in the death of all three dogs within 5 days after the last dose (one on the fourth and two on the fifth day).

The consistent effects of repeated doses of gossypol in the dogs were nausea, vomiting, diarrhea, anorexia, and marked weight loss. During the final period of gossypol administration the average food intake (dry basis) of each of the experimental dogs fell to 6.0, 0.4, and 3.0 g/kg body wt/day, respectively, while the control dog ate 28.0 g/kg body wt/day, and they lost 20, 26 and 25% of their body weight (the control dog lost 0.7%) within a period of 9 days. Post-mortem examination showed essentially the pathological findings reported for the rat, mouse, rabbit, and guinea pig (*2*), with marked lesions of focal necrosis involving the cecum, ileo-cecal valve, and adjacent portions of the large intestine. Further experiments are in progress.

It is suggested that the use of gossypol in human subjects be withheld until more data on its pharmacology and toxicology are available.

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[1] The samples of gossypol used in this study were supplied by the Southern Regional Research Laboratory, U.S.D.A., New Orleans, Louisiana, one of the laboratories of the Bureau of Agricultural and Industrial Chemistry, Agricultural Research Administration.

Application of Chromatography to the Separation of Subcellular, Enzymatically Active Granules

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It has recently been shown (*3*) that the chromatographic columnar adsorption method (*4, 6*) can be applied to the partial separation of biologically active particulates of virus dimensions from a chicken tumor extract. The present communication extends this chromatographic application to larger subcellular components, in the microscopically visible range, as found in pigmented mammalian tumors.

It has been found that melanized granules, varying in size from 0.2 to 0.6 μ or more, of the Cloudman S91 and Harding-Passey mouse melanomas, can be reversibly adsorbed on Celite columns (Fig. 1) and are thus subject to chromatographic manipulation. As a consequence, certain other constituents of the tumor homogenates employed as starting material can be readily separated from the granules, thereby providing a basis for noncentrifugal segregation of a substantial portion of the other tissue components. The particulate elements (*1, 2, 5*) separated by chromatography were found to possess high dopa oxidase and succinoxidase activities. As indicated by the

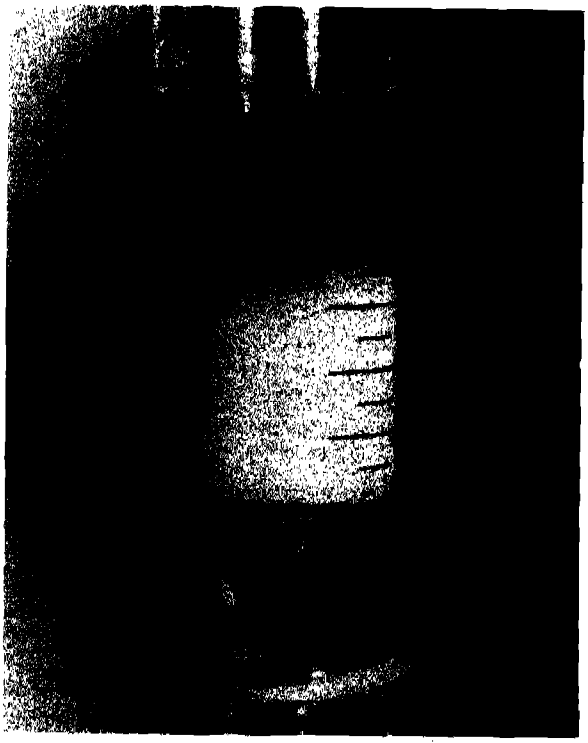

Fig. 1.—Adsorbed melanin granules on the developed chromatographic column prior to extrusion and segmentation.

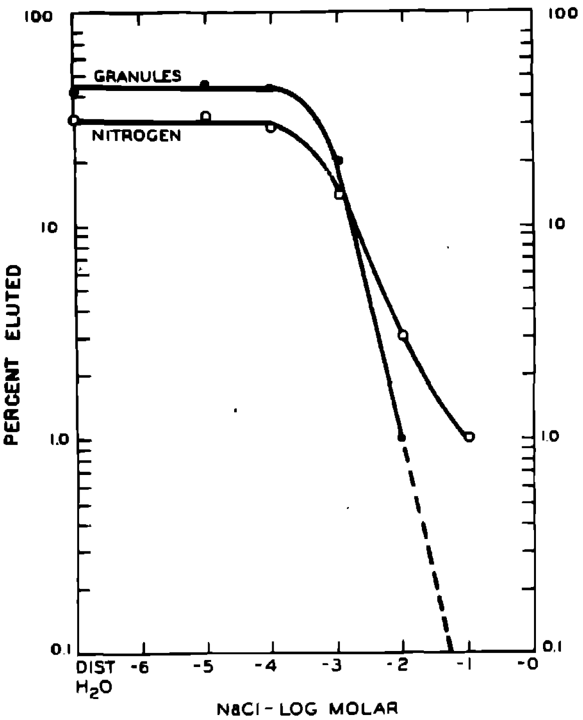

FIG. 2.—Effect of salt concentration on the elution of melanized granules and total nitrogen following the adsorption of equal quantities of a partially purified suspension on separate columns.

data below, granules so isolated possessed comparable or higher activities per unit of nitrogen than did the starting material, which had been partially purified by centrifugation, and considerably higher activities per unit of nitrogen than the starting extracts, where only preliminary centrifugal purification was employed.

In order to determine the adsorption and elution range of S91 melanin granules in this system, a curve was obtained by adsorbing from physiological saline equal quantities of granules (partially purified by centrifugation) on six identical 8 x 35 mm microcolumns. The columns were developed with 5 ml of additional physiological saline (0.154 M NaCl) and each column was then eluted with 10 ml of solution containing various concentrations of NaCl ranging from 10^{-1} to 10^{-6} M, and terminating with distilled water. Fig. 2 shows the influence of sodium chloride concentration on the elution of the melanin granules and total nitrogen, and indicates strong adsorption at 0.1 M, with continued influence through 0.001 M.

The percent granules eluted was estimated by measuring the optical density of the eluate at 650 mμ. A dilution curve of the centrifugally purified granules followed Beer's law, giving a straight line relationship with a zero intercept. Total nitrogen was determined by the Koch-McMeekin micro-Kjeldahl method,[1] and the enzymic activity of the granules was followed by their succinoxidase values determined manometrically in the Warburg apparatus. The pH of all solutions, including the tumor extracts, ranged from approximately 6.5 to 7.5. Within these limits, pH has little influence on adsorption or elution compared with the effect of salt concentration. In general, the adsorption and development procedures were carried out with cold solutions (2° to 10° C), while the elution was done with solutions at room temperature. The microcolumns were packed by introducing 5 ml of a 10% slurry of #503 Celite over a plug of absorbent cotton.

After establishing conditions for adsorption, development, and elution of the granules, the following experiment with a larger column was performed. Forty ml of a crude 20% S91 tumor extract[2] in saline was adsorbed on a dry Celite column 34 x 40 mm. A black zone of melanin granules formed in the upper part of the column and a pink zone containing hemoglobin and other tissue components developed immediately beneath the granules and migrated into the filtrate just behind a colorless zone of solvent. The column was developed with 40 ml of cold 0.154 M NaCl (0.9%), which was collected in the filtrate together with the pink fraction.

The moist column was extruded and cut into eight 5-mm segments, as illustrated in Fig. 3. In view of the adsorption-elution results shown in Fig. 2, each segment was separately eluted with distilled water, and the eluate tested for turbidity, succinoxidase activity, and nitrogen. The results are shown in Table 1 and Fig. 3. The data show that the granules were retained and subsequently eluted from the upper part of the column, while the preponderance of the starting nitrogen migrated into the percolate. This resulted in a more than 6-fold purification of the granules, as demonstrated by the relative increase in the succinoxidase $QO_2(N)$ value of fraction 2 compared with that of the starting material. The percolate (fraction 10), showed a corresponding decrease in activity, as did fractions 7 through 9. This adsorption behavior is similar to that found for the virus-like agent of chicken tumor I (*3*). The eluted particulate fraction 2 had a high population of melanized granules 0.3–0.6 μ in diameter, which were easily visible in the ordinary light and phase contrast microscopes.

If the above procedure is modified so that the elution is done by flowing chromatography rather than extrusion and segmentation, one black zone migrates down the column at a much faster rate than another, so that two distinct zones occur. While this indicates a chromatographic difference, or a change in a portion of the granules, the physiological or chemical differences of the two zones are yet to be studied. In experiments where this zone is left on the column it is expressed as elution inefficiency, as indicated in Fig. 2 and Table 1.

The association of the enzyme activity and the observed granules was attested by the fact that secondary centrifugation of such eluates at speeds just sufficient to sediment most of the particles yielded a fraction with succinoxidase $QO_2(N)$ values equal to or higher than the whole eluates. The same was also true for the dopa oxidase activity of the sedimented particles although, in contrast to succinoxidase, substantial quantities of dopa oxidase were also found in the saline and distilled water supernatants. Table 2 presents some of the dopa oxidase activities obtained when employing flowing chromatography. Further details concerning the different behavior of those two enzyme systems when manipulated chromatographically will be described elsewhere.

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[1] Determined in Mr. Charles A. Kinser's laboratory, National Institutes of Health.

[2] This extract was prepared by grinding the tumor tissue at 1°-5° C with 0.9% NaCl to make a 20% homogenate. This was centrifuged for 3 min at approximately 1,000 x gravity, the supernatant was poured off, and its volume adjusted with saline to reestablish the original volume and yield a 20% saline extract. Such extracts contained most of the melanin granules, together with some nuclei and other coarse particulate matter.

TABLE 1

RELATIVE DISTRIBUTION OF MELANIZED GRANULES, SUCCINOXIDASE ACTIVITY, AND TOTAL NITROGEN IN THE COLUMN ELUATES FOLLOWING THE ADSORPTION OF 40 ML OF A CLEARED TUMOR EXTRACT, AND DEVELOPMENT WITH AN EQUAL VOLUME OF 0.9% SALINE

Fraction	Oxygen consumption		Nitrogen		$QO_2(N)$		Optical density	
	µl/hr/ml	%	mg/ml	%	µl O_2/hr/mg N	%	D at 650 mµ	%
1. Starting extract*	10.7	100.0	1.48	100.0	11.3	100.0	1.40	100.0
2. Top 5 mm of column†	13.1	78.4	0.18	12.2	72.8	644.2	0.80	57.1
3. 2nd 5 mm of column	2.8	16.8	0.11	7.4	25.5	225.7	0.32	22.8
4. 3rd 5 mm of column	0.9	5.4	0.07	4.7	12.9	114.1	0.24	17.1
5. 4th 5 mm of column	1.5	9.0	0.07	4.7	21.4	189.4	0.20	14.3
6. 5th 5 mm of column	1.6	9.6	0.06	4.0	26.7	236.3	0.14	10.0
7. 6th 5 mm of column	0.2	1.2	0.052	3.5	3.8	33.6	0.09	6.4
8. 7th 5 mm of column	0.2	1.2	0.048	3.2	4.2	37.2	0.08	5.7
9. 8th 5 mm of column	0.3	1.8	0.062	4.2	4.8	42.5	0.07	5.0
10. Percolate‡	2.1	12.6	1.13	76.4	1.9	16.8	0.10	7.1

* See text footnote 2.
† All column segments eluted with 10 ml of solution, or ¼ the original volume of extract introduced on the column.
‡ Calculated at 40 ml starting volume.

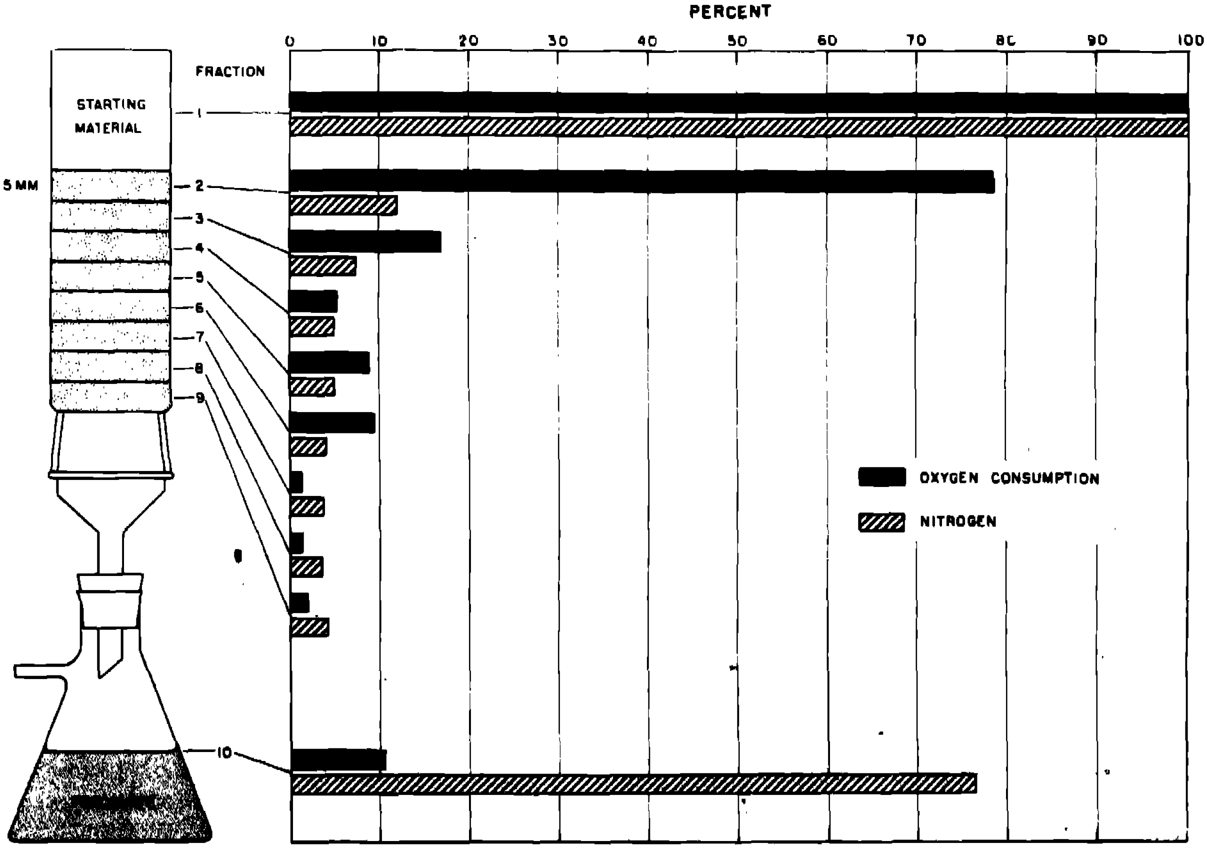

FIG. 3.—Distribution on the Celite column of melanized granules and other tumor components as indicated by the succinoxidase activity and the total nitrogen of the column eluates as compared with the percolate and the starting extract.

Preliminary studies have not shown any obvious staining or morphological differences in chromatographed granules as compared with smears or centrifuged preparations. There was, however, an apparent increase in uniformity of population. Fig. 4 shows an electron micrograph of Harding-Passey granules separated by flowing chromatography.[3]

TABLE 2

RELATIVE DOPA OXIDASE ACTIVITIES PER UNIT OF NITROGEN IN S91 MELANOMA FRACTIONS OBTAINED BY PARTIAL CENTRIFUGAL PURIFICATION FOLLOWED BY CHROMATOGRAPHIC SEPARATION

Fraction	$QO_2(N)$ Value			
	Exp. 1	Exp. 2	Exp. 3	Mean
1. Starting extract*	23.5	13.1	14.2	16.9
2. Sedimented granules†	79.5	31.4	27.0	46.0
3. Column eluate‡	225.1	130.6	147.5	167.7
4. Sedimented granules from eluate§	372.4	185.4	78.1	212.0

* This extract prepared essentially as described in text footnote 2 except for being cleared twice at approximately 1,000 × gravity.

† This granule suspension consisted of all the material sedimented by subjecting the cleared starting extract to a force of approximately 4,000 × gravity for 10 min. The resulting pellet was resuspended to the original volume with 0.9% NaCl.

‡ The 10-fold increase in enzyme activity of this fraction compared with the starting extract has a $P < .001$ and is thus highly significant statistically. It is not known at present whether removal of an inhibitor is involved in this increase or not.

§ The granules in the column eluate were sedimented in the same way and simultaneously with those obtained in fraction 2 from the starting extract. This pellet was also resuspended to its starting volume with 0.9% NaCl.

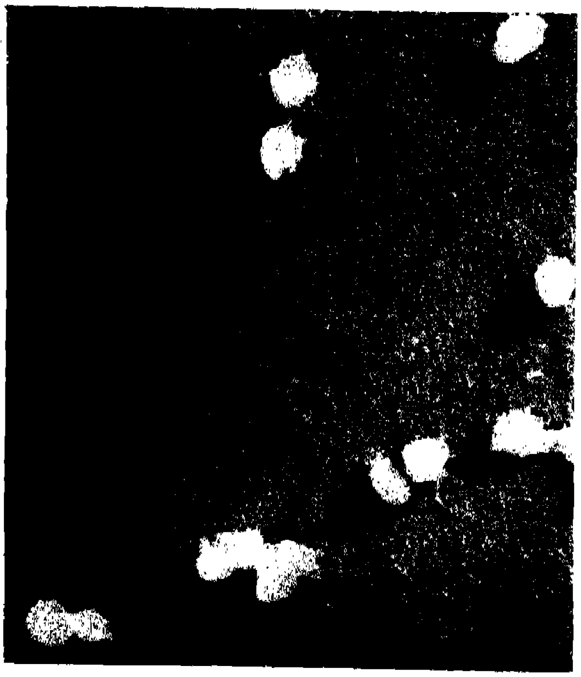

FIG. 4.—Electron micrograph of melanin granules from the Harding-Passey mouse melanoma obtained by chromatography. Gold shadowed at the approximate angle tangent 1/3. Magnification 8,000 ×. Enlarged to about 18,000 ×.

The adaptation of chromatography to particulates ranging from virus to mitochondrial and bacterial size provides another method for separation and characterization of the particulate components of the cell. Since columnar chromatography presumably exploits the surface and molecular configurations of particles rather than their mass or specific gravity, the method may provide a new attack on the problem of separating morphologically similar units possessing different physical or chemical surfaces.

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[3] Electron microscopy by Dr. Herbert Kahler and Mr. Bolivar J. Lloyd, National Cancer Institute.

Lygus Bugs in Relation to the Occurrence of Embryoless Seeds in the Umbelliferae

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In fresh seeds of various members of the Umbelliferae family, quite often a considerable number—sometimes 50% or more—will not germinate, although they appear well filled and in good condition. Examination of many different lots of umbelliferous seeds (*3*) has shown that the fresh seeds which failed to germinate were without embryos while those containing mature embryos gave satisfactory germination. In these embryoless seeds the endosperm is present and from all appearances normal while the very small embryo which normally lies imbedded in the endosperm at one end of the seed is lacking. In no other family have such high percentages of embryoless seeds been reported; embryolessness, if present in other groups, is usually found in less than 1% of the seeds. The notoriously poor germination of umbelliferous seeds is evidenced by the rather low minimum germination standards set by the Federal government—55% for carrot and celery and 60% for parsley and parsnip. Evidence is presented in this paper that embryolessness occurs following the caging of Lygus bugs (*Lygus oblineatus* Say[1] and perhaps others) with the developing seeds of carrot and dill, and the results suggest that these insects are responsible for the natural occurrence of embryoless seeds in these species.

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[1] Identified by Dr. Reece I. Sailer of U. S. National Museum.

Lygus bugs are widely distributed and are known to feed on many of our native wild and cultivated plants. They reduce seed crop yields by causing bud blasting, as well as blossom and young fruit drop in alfalfa, beans, and cotton (*6, 8, 10*), seed spotting and pitting in the common and lima beans (*1, 4*), shriveled empty seeds in alfalfa (*2*), and reduced germination in beet, cotton, and guayule (*5, 7, 9*). As far as the writer is aware, a relationship between embryoless seeds in the Umbelliferae and Lygus bugs has not previously been observed.

In attempts to determine the cause of embryolessness, various possible factors, such as type of soil, locality, weather conditions, pollinating insects, and genetical influence, were studied but none of these seemed to have any bearing on the problem. Embryolessness was found to appear at random from year to year, with no correlation in regard to position on the plant or within the umbel (flower cluster). However, there was some indication that the seeds within a pair sometimes behaved similarly. Within a given sample embryolessness was present in seeds of all sizes. It was noted that embryoless seeds seemed to appear at a rather late stage of seed development, usually after the endosperm was more or less completely formed—that is, when it was white and firm. Very little embryolessness occurred early in the season at Yonkers, New York, but it was often quite prevalent in the midseason and early fall crops.

Various types of insects found visiting the flowers and developing fruits of various members of the Umbelliferae growing in Yonkers were caged with dill plants. Embryoless seeds almost invariably occurred, usually in very high percentages, on the plants or specific umbels which had been caged with Lygus bugs. Except for a few instances, no embryoless seeds were produced in either the control plants (caged insect-free) or in plants caged with other types of insects, such as ants, aphids, bees, Japanese beetles, lady beetles, and syrphid flies. The presence of a few embryoless seeds under these circumstances indicated either that the Lygus bugs, especially nymphs, were not effectively excluded or that other factors, perhaps other insects, may occasionally have an influence in producing embryolessness. In the open field where dill plants were exposed to all types of insects, the percentage of embryoless seeds ranged from 0 to 62%, while no embryolessness occurred in the seeds from umbels protected from insects by cages. In the case of plants caged with Lygus bugs throughout the period of flowering to the production of mature seed, the amount of embryoless seeds obtained ranged from 1 to 100%, with an average of 58%. There was some indication that contact with Lygus bugs at the time of flowering or shortly thereafter reduced seed yield, while contact for only 48 hr at later stages of seed development produced embryoless seeds.

These results establish that the feeding of Lygus bugs produces embryoless seeds in dill. Preliminary results with carrot were similar. Details of these experiments are appearing elsewhere.

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A Metabolic Regulator in Mammalian Spermatozoa[1]

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The metabolic processes by which mammalian spermatozoa derive energy for motility have been a subject of investigation in this laboratory for some time. When the results of a series of studies (*8–15*) of the metabolism of bovine spermatozoa obtained from semen were compared with those of other investigators (*3, 4, 18, 19, 20*) who had studied epididymal spermatozoa, it became apparent that the metabolic pattern exhibited by bovine sperm cells from these two sources differed greatly. Since these workers (*3, 4, 18, 19, 20*) had used a wide variety of techniques and experimental conditions, a study was made (*7, 16*) of the metabolism of washed bovine epididymal spermatozoa in the calcium-free buffer-salts solution developed for ejaculated spermatozoa (*11*). Under these experimental conditions several metabolic differences between ejaculated and epididymal spermatozoa were observed. Those pertinent to the present discussion are:

(1) Most ejaculated spermatozoa have a vigorous endogenous respiration ($Q_{O_2} = 9$) (*10*). The addition of glucose results in a somewhat decreased rate of oxygen consumption (*8, 9, 12, 16*). In contrast, fresh epididymal spermatozoa have a comparatively low rate of endogenous respiration ($Q_{O_2} = 1–4$) while in the presence of glucose, respiration is appreciably greater ($Q_{O_2} = 2–6$) (*7*).

(2) Many specimens of ejaculated spermatozoa exhibit only a feeble Pasteur effect, *i.e.*, glycolysis in aerated media is almost as great as in the absence of oxygen (*8, 10, 14*). On the other hand, glycolysis by epididymal spermatozoa is 3–7 times faster under anaerobic conditions than it is in the presence of air (*7*). Certain specimens of ejaculated spermatozoa having a low endogenous respiration resemble epididymal sperm cells in that they exhibit a fairly strong Pasteur effect (*13, 14*)

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(3) Storage of excised epididymides alters their contained spermatozoa so that their metabolism more closely resembles that of ejaculated spermatozoa (7).

TABLE 1

AVERAGE RATES OF CATABOLIC REACTIONS IN BOVINE SPERMATOZOA*

	$-Z_{O_2}$		Z_L	
	Endogenous	+ Glucose	In air	In N_2
A. Epididymal	6	10	13	56
B. Ejaculated	20	16	20	25
C. Epididymal + regulator	20	22	20	85

* Z = mm³ gas exchange/100 million sperm cells/hr = 2.5 Q (*10*). Z_L = mm³ CO_2 equivalent to the lactic acid produced. The data represent averages of from 10 to more than 100 individual observations. Lactic acid was determined by the method of Barker and Summerson (*1*). Respiration measurements were made as described previously (7, *11*).

Data summarizing these observations are included in Table 1, lines A and B, and in Table 2, line A. The data here are expressed in terms of Z values[2] instead of the more conventional Q values since cell counts are more conveniently made than dry weight determinations.

It is interesting to consider these metabolic data together with observations of motility. Epididymal spermatozoa with a Z_{O_2} of 6 move almost as vigorously as do ejaculated spermatozoa with a Z_{O_2} of 20. It appears, therefore, that the ejaculated spermatozoa are not as efficient in converting the energy of oxidative reactions to motion. The respiratory processes of the ejaculated spermatozoa are also less effective in depressing the rate of glycolysis.

A search for the cause of these differences in metabolic efficiency and for the phenomena described under (3) has led to the discovery of a metabolic regulator which is present in a bound (inactive ?) form in epididymal spermatozoa and which is apparently liberated in an active form soon after ejaculation. When small quantities of this regulator are added to epididymal spermatozoa an increased rate of respiration and aerobic glycolysis results immediately (Table 1, line C). The metabolism of epididymal spermatozoa in the presence of added regulator closely resembles that of ejaculated spermatozoa. Anaerobic glycolysis is usually depressed by the regulator, especially at higher concentrations. The response to a single level of the regulator is shown in Table 1, line C. Greater quantities depress respiration and glycolysis and abolish motility.

The biological activity of the regulator appears to result, at least in part, from its ability to uncouple exergonic oxidations from the phosphorylation reactions with which they are normally associated (*6*). The regulator resembles dinitrophenol in that it stimulates cellular respiration and aerobic glycolysis while preventing energy utilization (*2*, *5*, *14*, *17*). We have devised an assay for the regulator based on its ability to stimulate the rate of aerobic fermentation by baker's yeast. Details will be presented elsewhere.

Using the yeast assay, it has been found that the regulator is present in a bound, inactive form in freshly ejaculated bull spermatozoa. During storage of semen at room temperature the substance is rapidly liberated from the spermatozoa into the seminal fluid in a water-soluble form which is still inactive for the yeast cell. The active substance is liberated from the water-soluble conjugate slowly during storage or more rapidly by mild alkaline hydrolysis. The substance liberated by hydrolysis is soluble in chloroform, ether, acetone, and petroleum ether. Alkaline hydrolysis is more effective in liberating the active form from the water-soluble conjugate than from the original bound form.

Fresh epididymal spermatozoa contain almost none of the free active regulator, but an appreciable quantity can be liberated by alkaline hydrolysis. When excised epididymides are stored in the refrigerator, the free form of the regulator is progressively released (Table 2). These results point to the likelihood that the increased rate of respiration of epididymal sperm following storage is brought about by the liberated regulator.

Furthermore, it seems probable that the free regulator liberated into semen after ejaculation is responsible for the higher rate of respiration of ejaculated spermatozoa as compared with epididymal spermatozoa.

We feel certain that the agent described plays an important role in the senescence of spermatozoa. If methods can be developed to prevent the liberation of the regulator or to counteract its effect once it is liberated, viable spermatozoa might be preserved for far

TABLE 2

EFFECT OF STORING EPIDIDYMIDES ON THE RESPIRATION OF THEIR CONTAINED SPERMATOZA, THE LIBERATION OF THE REGULATOR, AND THE RESPONSE TO ADDED REGULATOR*

Treatment	Time epididymides were stored at 5° C		
	3 hr	27 hr	51 hr
		ZO_2	
A. Control	9	14.4	18.8
B. Plus regulator; 0.65 units/ml	20.8	20.8	22.4
		Units of regulator/10^9 sperm cells	
C. Boiled spermatozoa .	.04	...	0.7
D. Alkali-hydrolysed spermatozoa	1.1	...	8.2

* One unit of regulator is the quantity required to give a half-maximum response in the standard yeast assay. Epididymal spermatozoa were washed with buffer-salts solution (*11*) before experimentation.

Respiration was measured in the presence of 0.01 M glucose. Alkaline hydrolysis was carried out by suspending cells in 0.17 N NaOH and heating 10 min on boiling water bath.

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[2] From the German "Zelle." The symbol was first used by Redenz (*18*).

longer periods of time than are now possible. The role of this regulator in sperm fertility is being studied.

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Lack of Depolymerase Effect on Desoxyribonucleic Acid in Living Cells

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Desoxyribonucleic acid depolymerase has been reported to remove ultraviolet light absorbing constituents and Feulgen stainable material, from nuclei in sections of tissue, and from nuclei of dead cells (*1, 2, 4*). There has been no reference in the literature, so far as the authors know, to the use of this enzyme on living cells.

In some experiments in this laboratory, it was found that the enzyme removed desoxyribonucleic acid from nuclei of chicken erythrocytes in smear preparations. After treatment with the enzyme, the nuclei failed to absorb ultraviolet light and did not stain with Feulgen's reagent. Addition of the enzyme to freshly obtained chicken blood, however, failed to affect the nuclei. This result suggested that perhaps living cells were unaffected by this enzyme when it was added to the extracellular fluid; results of further investigation showed that this is so with chicken erythrocytes and cells of Walker Carcinoma No. 256 of the rat.

Smears of chicken erythrocytes were fixed by immersion in 95% ethyl alcohol; they were then placed into fresh chicken blood to which had been added an equal volume of a solution of desoxyribonucleic acid depolymerase. The preparations were incubated at 37° C for periods of time up to 3.5 hr. In other experiments, suspensions of cells of Walker Carcinoma No. 256 of the rat in Ringer's solution were used in a similar manner. After incubation portions of the tumor cell-enzyme mixtures were transplanted into rats; if tumor growth followed it was assurance that the cells were living during the experiment.

The ultraviolet light (2654 A) absorbing material and the Feulgen stainable material in nuclei of the smears of both chicken erythrocytes and tumor cells were removed gradually and completely; however, there was no apparent effect on the nuclei of supposedly living chicken erythrocytes in the enzyme-blood mixture, or on the suspension of tumor cells. The tumor cells produced tumors after subcutaneous inoculation into rats; assuredly, they were living during exposure to the enzyme.

The enzyme attacked cells killed by heat, formaldehyde, alcohol, Carnoy's fixative, and ultraviolet light. Apparently the method of killing the cell makes little difference; it appears to be only necessary that the cell be dead for the enzyme to act.

Inability of the enzyme to act on the desoxyribonucleic acid of living cells might be explained by: a) absorption of the enzyme by cell constituents other than nucleic acid; b) antienzyme action; c) impermeability of cell membranes; d) inability of the enzyme to attack nucleic acid in the state that it exists in the living cell.

The possibilities that absorption and antienzyme activity prevented action of the enzymes on living cells were excluded by the fact that dead cells were acted upon by the same enzyme solution which failed to act on living cells. The assumption that membranes of the living cell are impermeable to depolymerase offers a plausible explanation for the lack of effect on living cells; however, it cannot be proved indisputably.

Whether or not other enzymes added to the exterior environment of living cells would fail to act on the respective substrates in cells is not known. Northrop (*3*), in 1926, reported that trypsin and pepsin were not taken up by cells of living organisms (earthworms, Euglena, yeast, meal worms, gold fish, and Fundulus), whereas, when the organisms died the enzymes were taken up rapidly from solution.

Desoxyribonucleic acid depolymerase did not act on nuclei of living chicken erythrocytes or of living cells of Walker Carcinoma No. 256 of the rat; the enzyme acted on these cells after they were killed. Lack of effect of the enzyme on living cells apparently was not because of adsorption of the enzyme or antienzyme activity, but may have been because of cell membrane impermeability or inability of the enzyme to attack nucleic acid in the state that it exists in the living cell.

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NEWS and Notes

National Science Foundation. On March 31, April 1, April 4, and April 5 the Subcommittee on Public Health, Science, and Commerce of the House Committee on Interstate and Foreign Commerce held hearings on the several bills designed to create a National Science Foundation. Seven of the ten members of Mr. Priest's Subcommittee were on hand when the hearings opened, and both Mr. Crosser, chairman of the Committee on Interstate and Foreign Commerce, and Mr. Wolverton, who was chairman in the 80th Congress, sat through the entire session and participated actively in the proceedings.

Mr. Priest reviewed the history and status of the legislation before introducing Detlev Bronk, who developed the need for a Foundation to guide publicly supported basic research. Representatives of the Engineers Joint Council and the American Cancer Society also spoke in favor of the legislation, following a summary of the current British system of public and private support of research by Sir Robert Watson Watt.

Friday's hearings opened with the testimony of George E. Folk, advisor to the Committee on Patents and Research of the National Association of Manufacturers. Mr. Folk said that the NAM favors the creation of a National Science Foundation but he expressed a number of objections to specific features of the present bills. The seven speakers who followed Mr. Folk spoke much more briefly. Congressman James E. Van Zandt and Dean Harry P. Hammond, of the Pennsylvania State College Engineering school, testified in support of the bills. Chancellor R. G. Gustavson, speaking in behalf of the Association of Land-Grant Colleges and Universities and the National Association of State Universities, urged the principle of mandatory geographic distribution of research funds but said that he personally believed that provisions of the present bills, if carried out in good faith, would safeguard that principle. Boris A. Bakhmeteff, of the Engineers Joint Council, approved of both H.R. 12 and S. 247 but felt the Senate bill was more flexible and practical. Dael Wolfle, secretary of the Inter-Society Committee for a National Science Foundation, and Hugh Wolfe, of the Federation of American Scientists, suggested several specific changes recommended by the groups they represented. M. H. Trytten, director of the Office of Scientific Personnel of the NRC, presented statistics showing the need for the scholarships and fellowships which the Foundation would provide.

Congressman Celler, author of H.R. 359, was the opening witness on April 4. He was followed by Karl T. Compton, who endorsed the bills under consideration in the name of the National Military Establishment and its Research and Development Board. The patent provisions of the bills were attacked by Harold J. Kinney, a Minnesota patent attorney, and endorsed by Lawrence C. Kingsland, Commissioner of the U. S. Patent Office. Sidney Kirkpatrick, representing the Associated Business Papers, expressed fear that the Foundation's authority to disseminate research findings might result in government competition with scientific and trade publications.

Ex-Congressman Lanham testified on April 5. The hearings were then adjourned until April 26, when two hours' time will be allowed to testimony by representatives of the American Patent Council.

DAEL WOLFLE

Theodore von Karman, advisor on aerodynamics to the California Institute of Technology and the U. S. Air Force, is leaving this month for scientific conferences in Europe. Dr. von Karman recently resigned as director of Caltech's Guggenheim Laboratory of Aeronautics and chairman of the Jet Propulsion Laboratory Board, to devote more time to the Air Force and his own research and consulting work, but is continuing as advisor of the laboratories.

Charles T. Brues, professor emeritus of entomology, Harvard University, will spend the next nine months doing biological research at Silliman University, in the southern Philippines, under the auspices of the International Educational Foundation. Mrs. Brues, who is accompanying him, will make motion pictures of the plant and animal life of the region, under the sponsorship of the Fulbright Programs Branch of the U. S. Department of State.

Visitors to U. S.

Recent visitors from Britain include: **Sir Henry Tizard,** chairman of the Defense Research Policy Committee, Ministry of Defense, who came for the Massachusetts Institute of Technology mid-century celebrations; **S. Zuckerman,** University of Birmingham, and **R. L. Smith-Rose,** director of Radio Research, Department of Scientific and Industrial Research, now visiting radio research establishments in the U. S. and Canada. These men may be reached through the British Commonwealth Scientific Office, 1785 Massachusetts Avenue, N.W., Washington, D. C.

Edy Velander, managing director of the Swedish Royal Academy of Engineering Sciences, will arrive in this country, about the middle of April. He plans to attend the United Nations Scientific Conference on the Conservation and Utilization of Resources, in June, as a delegate from Sweden, and will also speak at a dinner meeting of the New York Section of the Institute of Food Technology on April 20.

Grants and Awards

Eileen R. Cunningham, librarian of Vanderbilt University School of Medicine, will be the first recipient of the **Marcia C. Noyes Award** of the Medical Library Association, to be presented at the Association's annual meeting, April 11, in Galveston, Texas.

The 1948 Lamme Medal of the American Institute of Electrical Engineers has been awarded to V.

K. Zworykin, vice president and technical consultant RCA Laboratories Division, Radio Corporation of America, Princeton, New Jersey, for his contribution to the concept and design of electronic apparatus basic to modern television. The medal will be presented to Dr. Zworykin at the Summer General Meeting of the Institute to be held in Swampscott, Massachusetts, June 20–24.

Colleges and Universities

The Premedical Society of the University of New Hampshire, Durham, was recently installed as the New Hampshire Alpha chapter of **Alpha Epsilon Delta**. Harold A. Iddles and Albert F. Daggett, department of chemistry, were initiated as honorary members, along with 32 premedical students. George Moore, department of zoology, will serve as faculty advisor.

Sigma Xi will install its 102nd chapter at Temple University, Philadelphia, on April 28. Installing officers will be Carl D. Anderson, national president of the Society, Nobel Laureate, and professor of physics at California Institute of Technology, and George A. Baitsell, executive secretary of the Society, and professor of biology at Yale University. The honorary degree LL.D. will be awarded to William H. Taliaferro, University of Chicago, and to Dr. Anderson, who will also deliver the installation address, ''New Particles of Matter.''

Western Reserve University's Department of Physiology is offering a new 12-month training course in the disciplines of cardiovascular research, supported by the American Heart Association and the National Heart Institute, U. S. Public Health Service. If the enrollment warrants, the course will begin July 1; otherwise it will begin September 1. Further information may be obtained from C. J. Wiggers, Western University Medical School, Cleveland 6, Ohio.

The **Four College Research Conference on Growth and Differentiation**, whose membership is drawn from the faculties of Amherst, Mt. Holyoke, Smith, and the University of Massachusetts, recently held its first meeting at Amherst. The organization, limited to active research workers whose projects are being supported by outside foundations such as the American Cancer Society, the Atomic Energy Commission, and the National Institutes of Health, offers an opportunity for intimate discussion of current research findings on growth and differentiation.

The Zoology Department of the **University of Massachusetts** is conducting an integrated interscience seminar on the Organization and Structure of Protoplasm. Discussions are presented by graduate students, members of the zoology, chemistry, and bacteriology departments, and by speakers from other universities, including E. W. Dempsey, of Harvard, Jytte Muus, of Mt. Holyoke, E. J. Boell, of Yale, and F. O. Schmitt, of the Massachusetts Institute of Technology.

Meetings and Elections

The Academy of World Economics announces that its 27th annual forum sessions will be held the evenings of April 12 and 13 at the Brookings Institution, Washington, D. C. The current sessions on ''American Foreign Economic Policy'' will be held in conjunction with the National Social Science Honor Society, Pi Gamma Mu, and with the Washington chapter of the American Political Science Association. The proceedings of the sessions will be published in the July issue of the quarterly journal *Social Science*.

The Foundation of Applied Research will hold a national conference on ova transplantation on April 14 in San Antonio, Texas. Phases in egg transfer and superovulation techniques will be discussed by biologists, embryologists, and geneticists, and a report on the Foundation's seven years of experimentation in ova transplantation, designed to enable scrub cattle to give birth to registered, high quality animals, will be made.

The Southeastern Section of the Botanical Society of America will hold its spring meeting April 14–16 in conjunction with the Association of Southeastern Biologists, the Southern Appalachian Botanical Club, and the Kentucky-Tennessee Branch of the Society of American Bacteriologists at the University of Tennessee, Knoxville. A Central States Section of the Botanical Society of America has recently been organized and has elected the following officers: Paul Weatherwax, Indiana University, president; Edgar Anderson, Missouri Botanical Garden, vice president; and Oswald Tippo, University of Illinois, secretary-treasurer. This new section will hold its summer meeting jointly with the Northwestern Section in late August at the University of Michigan and the Cranbrook Institute of Science.

The Association for Computing Machinery will hold a three-day meeting, April 18–20 at the Oak Ridge Institute of Nuclear Studies, Oak Ridge, Tennessee. This will be the third national meeting of the association. A ''604'' multiplier, recently developed by the International Business Machines Corporation, will be demonstrated.

Centre National de la Recherche Scientifique announces that a **Symposium on Thin Films** will be held in Marseille, France, April 18–23. American scientists invited are: John Strong, Department of Physics, Johns Hopkins University; A. F. Turner, Scientific Bureau, Bausch and Lomb Optical Company, Rochester, New York; Bruce B. Billings, Director of Research, Baird Associates, Inc., Cambridge, Massachusetts; and Noel W. Scott, Radiation Branch, Engineer Research and Development Laboratories, Fort Belvoir, Virginia.

The National Academy of Sciences will hold its annual meeting April 25, 26, and 27, at 2101 Constitution Avenue, Washington, D. C. A public lecture will be given April 25, at 8:00 P.M., by Sir Harold Spencer Jones, Astronomer Royal, Royal Greenwich Observatory, England. His topic will be ''The Measurement of the Sun's Distance.''

The Kansas Academy of Science will hold its 81st annual meeting at Kansas City College, Manhattan, Kansas, April 28–30. Cooperating societies are the Kansas Entomo-

logical Society, the Kansas Psychological Association, and the Kansas chapters of the American Association of University Professors.

The Society for Applied Spectroscopy will hold a symposium on "Theory and Application of Spectroscopy" May 21, at Brooklyn Polytechnic Institute, Brooklyn, New York.

The Fourth Annual AAAS-George Westinghouse Science Writing competition for an award of $1,000 to the writer of the outstanding newspaper story on science during the year 1949 has been announced. Another $1,000 will go to the writer of the outstanding magazine story of the year. Both awards, made possible by a grant from the Westinghouse Educational Foundation, are administered by the American Association for the Advancement of Science.

The rules governing the newspaper competition require each entrant to submit three separate articles published during the contest year (in newspapers published in the continental United States and dated between August 1, 1948, and September 30, 1949), and to designate one of the three as the entry upon which he wishes to be judged. All three may have been published by the same newspaper or carried by the same press association.

The magazine entries must have been printed in an American nontechnical magazine of general circulation and dated between August 1948 and September 1949, inclusive. Publications printing or distributing the winning newspaper and magazine articles will receive scrolls at the December meeting of the AAAS, when the winners of the 1949 awards will be announced. Although articles appearing in AAAS journals are automatically ineligible, readers of *Science* are invited to nominate suitable entries. All entries must be posted before midnight, October 8.

Entry blanks with detailed rules for the 1949 AAAS-George Westinghouse Science Writing Awards may be secured from the Managing Committee, Howard A. Meyerhoff, chairman, 1515 Massachusetts Ave., N.W., Washington, D. C.

Winners of the 1948 awards of $1,000 were Frank Carey, science writer in the Washington Bureau of the Associated Press, for his series of four articles on chloromycetin, and Florence Moog, of Washington University, St. Louis, for her article "The Biology of Old Age," published by the *Scientific American*.

Herbarium specimens of about 1,000 species have been collected on the Burma-India border during the past year by F. Kingdon-Ward on an expedition initiated by the New York Botanical Garden. The purpose of the expedition, begun early in 1948, is to obtain plant material, especially ornamental species, that will be suitable for culture in the U. S. To date, seeds of 260 plants have been received, none known to be cultivated in this country. The seeds have been distributed among the joint sponsors of the expedition—the New York Botanical Garden, the Huntington Botanical Garden of San Marino, California, Edward B. Stern of New Orleans, and Suydam Cutting of New York—and additional lots have been presented to growers in regions of the U. S. where they are expected to thrive.

The National Bureau of Standards' radio station WWVH, recently established on the island of Maui, Territory of Hawaii, is now broadcasting on an experimental basis continuous time and frequency standards on 5, 10, and 15 megacycles. The new station offers the Pacific area four useful technical services—standard radio frequencies, time announcements, standard time intervals, and standard musical pitch. WWVH's program of broadcasts is essentially the same as that of the Bureau's Beltsville, Maryland station WWV and it is expected that the new station may be received at many locations not served by WWV in the Pacific area. The ultimate aim of the International Telecommunications Union is to provide continuous world-wide coverage by means of suitably located stations all operating on the same frequencies without interfering with the widely used services from WWV.

University of Wisconsin scientists recently completed experiments which indicate that agene, the bleaching agent used in flour, is not a cause of human epilepsy, as has been thought. Collaborators on the experiment were C. A. Elvehjem, department of biochemistry, College of Agriculture; G. W. Newell and S. N. Gershoff, industrial fellows in biochemistry, T. C. Erickson, neurosurgery, and W. E. Gilson, medical electronics, School of Medicine. According to a report in the February *Journal of laboratory and clinical Medicine*, a control group of 19 persons, five of them epileptics, showed no ill effects after being fed a diet containing high concentrations of agene. The tests covered periods up to 210 days.

The National Society of Inventors, Inc., has established a Washington, D. C. chapter headquarters. Those interested in technological and engineering research and development may obtain further information from Lewis H. Renshaw, chairman, or John H. Haas. secretary-treasurer, 930 F Street, N. W., Washington, D. C.

The new national reactor testing station will be established on the Snake River plains of Idaho, the U. S. Atomic Energy Commission announces. Negotiations are under way with the Navy for the transfer to the Commission of the Naval Proving Grounds at Arco, which are included on the proposed site. The total area of the grounds will be about 400,000 acres, comparable in size to that of the Hanford plutonium production center on the Columbia River in Washington. All but about 20,000 acres are government owned land.

Make Plans for—

Southern Society for Philosophy and Psychology, April 14–16, Biloxi, Mississippi.

American Association of Pathologists and Bacteriologists, annual meeting, April 15–16, Boston, Massachusetts.

American Geophysical Union, 30th annual meeting, April 20–22, Washington, D. C.

A Color Translating Ultraviolet Microscope[1]

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H. Husek, R. C. Jones, C. H. Matz, and D. P. Merrill

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THE DESIGN of monochromatic ultraviolet microscope objectives by Köhler and von Rohr (*13, 14*), their commercial production by Zeiss, and their use in conjunction with photographic film marked an important step forward in man's ability to see very small structures in spectral regions where his eyes are not sensitive. Many investigators (cf. *7, 8, 9, 16, 17, 21*) have used this ultraviolet microscope in the examination of plant and animal tissues. Ultraviolet microscopy of such substances has been useful because the inherent absorption of biological materials in the ultraviolet region makes possible photography without the use of dyes or stains, and because the shorter wavelengths of the incident radiation allow approximately twice the resolving power that can be obtained with visible light.

The well-known Zeiss ultraviolet microscope objectives, because they are monochromats, are restricted to use at one wavelength for a given focal setting. On the other hand, the microscope described here is not only achromatic, but also apochromatic from 220 to 800 mμ. This makes possible a new conception of the method of using an ultraviolet microscope; namely, to use simultaneously or sequentially three different ultraviolet wavelengths, and to convert the ultraviolet images so obtained into visible images in three primary additive colors. When these three images are superposed, a visible image in full color is obtained. This procedure was earlier suggested by Brumberg and others (*4, 5, 23*). The colored image which is seen might be thought of as what the eye would see in the microscope if its receptors had their peak sensitivities at the ultraviolet wavelengths in question.

We now wish to present a preliminary description of a system of ultraviolet microscopy and an instrument which employs this procedure. The system employs photography with rapid development and fixation to convert the ultraviolet image into a visible image. The procedure involves image formation with an apochromatic ultraviolet microscope objective (*11*), exposure of successive areas of the film using three different wavelength bands of ultraviolet light, rapid development and fixation of the three latent photographic images, and the simultaneous projection of the three fixed images through three additive color filters to give a full-color representation of the object in terms of its ultraviolet absorption. Although other means of wavelength translation such as fluorescent screens and television methods have been considered (*12*), it was decided on the basis of sensitivity, availability, and particularly retention of a permanent record, first to develop an instrument using photographic techniques.

The instrument (Fig. 1) employs a superhigh pressure, water-cooled mercury arc (Type A-H6) as a light source (A), a Wadsworth-type grating monochromator (B), a microscope (C) using apochromatic objective lenses and identical lenses as condensers, the camera (D) which employs 35-mm motion picture film, the film-processing station (E), the three-beam projector (F), and the viewing screen (G). The instrument will be described in detail in a subsequent publication, but it is perhaps worth while to mention at this time a few pertinent characteristics of the components now in use.

A.) The characteristics of the superhigh pressure mercury arc have been described (*1, 2, 10, 22*). This source was found to be the brightest of a great variety of sources examined in the region 260 to 400 mμ. Exposure times required vary from 0.01 to 30 seconds, depending not only on the wavelength region, the film type, and developing conditions, but also to a considerable extent on the age of the arc. The achievement of proper exposure will be facilitated by an automatic photoelectric exposure control device now under construction.

B.) The monochromator was designed and constructed in this laboratory and employs a Baird Associates 15,000 line per inch grating (B_1) approximately 3 by 1.5 inches in area. Settings for wavelength are made reproducible by means of micrometer-controlled stops. Band widths are controlled by slit size.

C.) The optical system of the microscope will be described in more detail in a subsequent communica-

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[1] This work has been supported since its origination by the Office of Naval Research, and is now being sponsored jointly by that Office and the American Cancer Society.

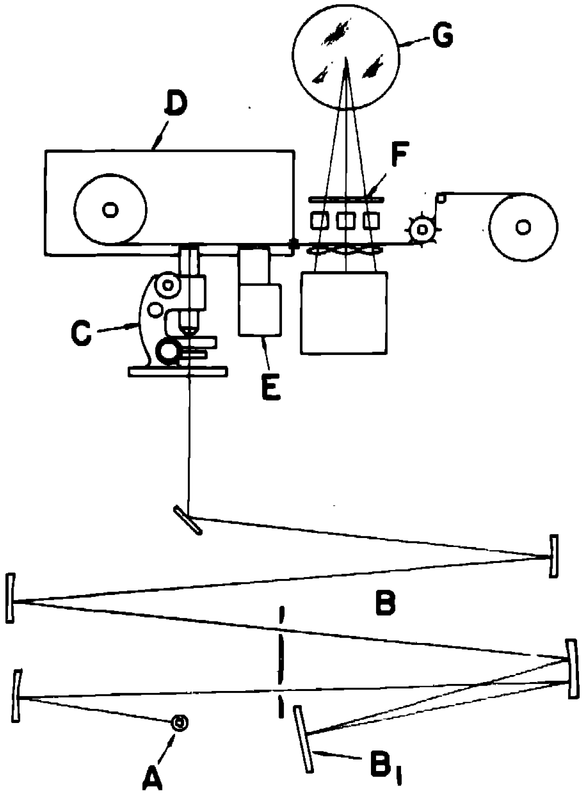

FIG. 1. Schematic diagram of color translating ultraviolet microscope: A—light source, B—monochromator, B_1—diffraction grating, C—microscope, D—camera, E—film processing station, F—three-beam projector, G—viewing screen.

tion (*11*). The objective and condenser are apochromatic over the wavelength range 220–800 $m\mu$. This of course means that it is now possible to focus the microscope for ultraviolet light by focusing it with visible light; this eliminates what has previously been one of the most difficult aspects of ultraviolet photomicroscopy. Two objectives, one of a reflecting type (*6, 18*) and one of a combined reflecting-refracting type, having numerical apertures of 0.4 and 0.72 respectively, have been designed and constructed. These lenses fit into a standard microscope stand (Fig. 2) and may be used as condensers as well as objectives, although an achromatic quartz-fluorite ultraviolet condenser has also been made. The objectives may be used without eyepieces and provide magnifications of 77 × and 200 × before projection. Lenses of higher numerical aperture and with similar apochromatic properties are now being developed.

D.) The main requirement of the camera is that successive frames be indexed very accurately (to at least 0.001 inch), so that the subsequent triple projection is in register. Approximately 400 feet of 35-mm film can be used in one loading.

E.) After the film is exposed, it moves on automatically to the film processing station, where successive treatment of the emulsion with hot alkaline developer, hot fixer, water, and air produces within 10 seconds a stable negative suitable for projection (*3*). The useful diameter of the processing cup is 0.7 inch, and therefore this is also the diameter of the developed area. The principal mechanical-chemical problems of fast processing, such as time cycle, temperature control, and homogeneity of processing, have been solved.

F.) After the development and fixation of the negative image, the film is moved on to a projector, where three images which had been taken successively at three different ultraviolet bands are projected simultaneously through three additive color filters (red, green, blue) upon a 4½-inch circular translucent screen. The magnification from the film to the screen is eight times. The resulting single, full-color image is reasonably sharp and bright, and may be viewed by several persons simultaneously.

The relationship between the visible and ultraviolet bands may be chosen for maximum color contrast, since there are no "natural" colors. With three ultraviolet bands and three visible colors, there are six possible combinations of the images and filters. In addition there is the possibility of processing the ultraviolet image to yield a positive rather than a negative. We have examined the six negative and six positive color combinations, using ultraviolet photo-

FIG. 2. Apochromatic reflecting-type microscope lenses in conventional stands: 0.4 NA objective lens (left); 0.72 NA objective lens (right); identical lenses used as condensers.

micrographs of tissue sections, and, on the basis of using equal gammas and equal background densities in the negatives, have selected the following as showing the greatest color contrasts:

Ultraviolet Wavelength	*Visible Wavelength*	
	Negative	*Positive*
Short (~ 265 mμ)	Green	Blue
Medium (~ 285 mμ)	Red	Green
Long (~ 315 mμ)	Blue	Red

We are not unmindful that with the use of other ultraviolet wavelengths or the use of other photographic procedures, different color combinations may show better color contrast.

In the mechanical arrangement employed in the instrument, the visible color filters are segments of a rotatable disc arranged so that as each new image is developed and moves into the projector, an image that had been projected through the same color filter moves out of the projector; and the two remaining images are advanced one frame, along with their respective filters. Thus the desired correspondence of ultraviolet and visible wavelengths is maintained once it is set.

G.) The clear screen brightness obtained through the three filters is about 100 foot-lamberts. Use is made of a special plastic-in-plastic screen (*15*) which gives the maximum screen brilliance, maximum evenness of illumination, and maximum definition of any of the many different types of translucent screens we have investigated. The addition of a plastic Fresnel condensing lens (*20*), placed directly back of and in contact with the screen, aids in achieving even illumination.

The device is called a color translating microscope, rather than a micrograph, because the manipulative operations involved and the general time requirements are rather similar to those involved in ordinary visual microscopy. One sits adjacent to the microscope, moves the slide about on the microscope stage, changes the focus as desired, and—without significant delay—studies the magnified, full-color image. The instrument is different from an ordinary microscope in that it permits several persons to view the image simultaneously, provides permanent records of what is seen, and of course permits observation of specimens in terms of their ultraviolet absorption.

In Fig. 3 we have reproduced three black-and-white ultraviolet photomicrographs of the type used for color projection. Unfortunately, since full-color printing is not used in this journal, we are unable to reproduce a color photomicrograph with this article.

Finally, it should be pointed out that the 35-mm black-and-white film, with its groups of three images, each corresponding to a different ultraviolet band, provides a permanent photographic record of each experiment, which can be examined at leisure, or each group of three images may be processed into a single full-color photograph. For example, a picture may be taken of the image on the projection screen with color film such as Kodachrome or Anscocolor, or the black-and-white negatives may be used as color-separation negatives in the Technicolor or Polacolor processes. This color film may then be viewed in an ordinary 35-mm motion picture or slide projector, thus

FIG. 3. Positive print from a 35-mm film strip showing three pictures taken at peak transmissions of 315 mμ (left), 285 mμ (center), and 265 mμ (right); band width approximately 10 mμ in each case; photographed with 0.4 NA apochromatic reflecting lenses used as objective and condenser; subject, unstained intestinal carcinoid showing argentaffine cells; specimen (furnished by Dr. Maurice L. Pechet, Children's Hospital, Boston, Massachusetts) prepared by formalin fixation, embedded in paraffin, cut at 4 μ thickness, and mounted in glycerin on Vycor slide.

making possible careful, prolonged study of subjects of ultraviolet color-translation photomicrographs.

We wish to acknowledge the invaluable technical assistance of the following members of our research staff: Messrs. A. G. Carpenter, M. Fairbank, M. Parrish, Jr., N. T. Pierce, and S. A. Stone, and also Dr. S. S. Ballard, Consultant in Physics to Polaroid Corporation. We are indebted to Dr. R. C. Mellors and Dr. C. P. Rhoads of the Sloan-Kettering Institute for Cancer Research for supplying us with many specimens of tissue used (19) and for valuable advice and encouragement from the inception of this work. We also wish to acknowledge the excellent cooperation of Mr. L. V. Foster and the staff of Bausch and Lomb Optical Company in the construction of the microscope lenses, that of Dr. H. C. Yutzy and the staff of Eastman Kodak Company in supplying special photographic films, and the able assistance of Mr. Clifton Tuttle of Kenyon Instrument Company in the engineering of the developing unit and projector.

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Examination of the Target Theory by Deuteron Bombardment of T-1 Phage

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THE BIOLOGICAL ACTION OF IONIZING RADIATIONS is of great current importance. The effects produced are often readily measured and a clear understanding of the process involved is therefore capable of yielding structural information about biological systems.

Lea (*2*) has examined carefully the target theory of biological action according to which a localized sensitive volume of definite size exists and within which there must be considerable liberation of energy for biological action to take place. This direct action is certainly not the only action and Lea has pointed out that indirect action by free radicals and by hydrogen peroxide will occur, particularly at low concentrations. According to his views a specimen irradiated in high concentration, and in the presence of a high concentration of large molecules, should have a low efficiency for indirect action and the direct, target type action should predominate.

There is today some question as to whether direct action ever occurs, since the similarity of action of mutagenic agents like nitrogen mustard and of X radiation is very striking, and certainly mutagenic agents must operate by collision rather than by penetration and ionization.

In view of this present uncertainty it appeared to us to be worth while to examine the target theory carefully in bombardments where it should certainly be valid. For this we chose T-1 bacteriophage (*1*) which acts on *E. coli*, strain B. This phage has a spherical head, diameter 50 mμ and a long tail, length 120 mμ of diameter 10 mμ. No complex genetic structure has been reported for this phage. We found it to be

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[1] We wish to thank Mrs. Marjorie Reaume for very valuable help with the phage assays, Mr. F. Bishee for help in constructing the bombarding equipment, and Drs. P. R. Burkholder and D. M. Bonner for much interest and helpful advice.

stable in broth, 0.4 grams percent. The stability was not affected by evacuation for several days. Our procedure was to bombard T-1 phage preparations in vacuo with a deuteron beam of known energy and to study the cross section of target resulting from such bombardment. By varying the energy of the deuteron beam the ionization density can be varied smoothly and accurately and a test of the target theory made.

Since the deuterons go in straight lines, distributed in a random manner in area, the target calculation assumes only that a deuteron passes through the target area. The chance of inactivation of N phage particles having a target area S each is then SN/A where A is the area of the whole preparation. The actual number of hits is given by $-dN$, and the chance is this number divided by the total beam, which is the preparation area times the number of deuterons per square centimeter or dB. This expression for the chance is $-dN/A\ dB$, and equating the two we have

$$\frac{SN}{A} = -\frac{dN}{A\,dB}$$

which leads to the relation $dN/N = -S\ dB$ or on integrating

$$\frac{N}{N_0} = e^{-SB} \tag{1}$$

where N_0 is the number of phage particles present initially. When $N/N_0 = 37\%$, $SB = 1$ and in this way, by measuring B, S can be found.

The results are plotted as percent survival versus number of deuterons per cm² and show that relation 1 is obeyed. The results for three different beam energies are shown in Table 1.

TABLE 1

Beam energy (Mev)	Energy loss per cm air (Mev)	B for 37% survival ($\times 10^{11}$ deuterons)	Apparent radius mμ
3.5	0.18	1.2	16.5
2.5	0.25	1.04	17.5
1.5	0.40	0.83	19.5

The value of the apparent radius, assuming the target to be a spherical volume, is given, together with the value of B for 37% survival and the energy loss of the beam per centimeter air equivalent.

The number of ion pairs introduced into a target of this volume is in each case in excess of 8 so that on the simple hypothesis of Lea that one ion pair liberated in the target produces inactivation, the target should appear to have the same area. The fact that it does not requires some modification of the theory.

In order to have some basis for this modification, we studied the temperature inactivation (in broth) of the same phage. The results are given in Table 2.

TABLE 2

Temperature (absolute)	K (sec⁻¹)
343	2.78×10^{-3}
338	7.94×10^{-4}
336	1.93×10^{-4}
333	5.03×10^{-5}

These show that there is an activation energy for the inactivation process of 73.6 kcal per mole or 3.2 ev. This, of course, includes a large amount of entropy change. Nevertheless, if it is assumed that the absorption of 3.2 ev of energy in a target of diameter about 30 mμ will cause inactivation it is possible to estimate the distance from which radiation can reach the target to produce inactivation. This distance increases with ionization density and accounts for the apparent increase in the target area.

It is therefore proposed that Lea's hypothesis be modified by including the possibility that inactivation can be caused by secondary radiation reaching the target from an ion path which does not go through the target. An approximate quantitative treatment can be given as follows. Suppose I ev/cm² are released by the deuteron. Let the path of the deuteron approach within a distance y of a target of radius R. Then it can be assumed that approximately the intensity at the surface of the target is aI/y, where a is some slowly varying quantity dependent on the proportion of energy emitted as ultraviolet light suitable for inactivation and on absorption in the medium. If the absorption coefficient of the target is μ then the energy absorbed is approximately $\dfrac{2\pi\mu aIR^3}{y}$ so that the condition for inactivation is

$$\frac{2\pi\mu aIR^3}{y} = 3.2.$$

This can be rewritten as $y = \left[\dfrac{2\pi\mu aR^3}{3.2}\right] I.$

This equation cannot be interpreted literally since the requirement that 3.2 ev be sufficient is clearly only a hypothesis and also the approximations regarding absorption are rather rough.

However, the ideas it expresses can be put to good use. If one regards the term in brackets as constant, and it is essentially so, one can write

$$y + R = \text{constant} \cdot I + R$$

Now $y + R$ is the radius of the apparent target volume as calculated above. When $y + R$ is plotted against I

(Continued on page 386.)

TECHNICAL PAPERS

Direct-reading Photocolorimetry

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The use of photocolorimeters is becoming increasingly widespread and in many laboratories has completely supplanted the visual colorimeter. When large numbers of analyses are made, the calculation of results may become a time-consuming chore. It is possible to simplify such calculations by an expedient whereby the scale readings are made to express directly the quantities of the unknown substance analyzed. When applied to the analysis of blood sugar, the result in mg per 100 ml can be read directly from the scale of the Klett-Summerson photocolorimeter. The method is applicable also to other types of photocolorimeters.

The relationship between the density of the color in the solutions derived from the standard and unknown samples and their respective concentrations is illustrated in the equation

$$C_u = (R_u - R_b)\,\frac{C_s}{(R_s - R_b)}$$

in which C_u and C_s are the concentration of material analyzed in unknown and standard samples; R_u, R_s, and R_b are the readings in terms of optical density of unknown, standard, and blank samples.

If R_b reads zero or if the instrument is adjusted so that $R_b = 0$ then the foregoing expression becomes

$$C_u = R_u\,\frac{C_s}{R_s}$$

It will be seen that if $R_s = C_s$, then $C_u = R_u$ and no calculation is necessary. This relationship seldom is encountered; however, it can be established or closely approximated by selection of a filter or wavelength setting that will have the effect of expanding or contracting the light absorption for each unit of substance to make it divisible evenly into the units of the scale. An adjustment of shutter or galvanometer setting then can make R_s equal to C_s or to some simple multiple of C_s, nC_s. Then

$$C_u = (R_u - R_b + d)\,\frac{C_s}{(R_s - R_b + d)}$$

where d represents the effect of the shutter adjustment. If the relationship between light absorption of the solution and filter is such that the change from $R_b = 0$ to $R_s = nC_s$ is small then d will be small and for values of C_u near C_s, R_u will be approximately equal to C_u. The error at $C_u = 0$ is given by the deviation of R_b from zero.

To illustrate, the following procedure was used in adapting the Somogyi-Nelson blood sugar method to this system of measurement by means of a Klett-Summerson photocolorimeter. Three standard solutions containing glucose equivalent to blood sugar concentrations of 50, 100, and 200 mg per 100 ml respectively, and a blank tube containing reagents only were prepared together with the unknowns. A filter having maximum transmission at 540 mμ was tested first. With the cuvette containing the blank in position and the dial scale set at zero the shutter was adjusted to give a null reading on the galvanometer. Next the three standards were read and scale readings of 65, 120, and 245 were obtained. Since these values were not conveniently convertible to the corresponding blood sugar values, a filter having maximum transmission at 500 mμ was tested. The adjustment of the blank to zero was repeated, and the three standards now read 54, 103, and 205. These readings approximated the desired range and this filter consequently was selected. For measurement of blood sugar in the normal range, the cuvette containing the 100 mg standard was placed in the instrument. The dial was set to 100 and the galvanometer restored to the null point by means of the shutter adjustment. Readings of the unknowns were then taken directly from the dial. They agreed (within the limits of error of the readings) with the blood sugar values for the same specimens calculated by a conventional procedure.

When the method is applied to photocolorimeters scaled to read transmissions, a setting is selected that will give a simple fraction when converted to optical density. To illustrate, the method used in this laboratory for determination of cholesterol employs the Evelyn photocolorimeter. Two standards containing 0.4 mg and 0.8 mg of cholesterol together with the unknown samples are treated with acetic anhydride and sulfuric acid. With the reagents currently in use, and when conditions for development of color are kept uniform, galvanometer readings of the 0.8 mg standard closely and consistently approximate 32. With the colored solution derived from the 0.8 mg standard in place, the galvanometer is set at 31¾. The optical density (L value) corresponding to this is 0.498. Dividing it into 0.8 gives a quotient of 1.6. While this quotient is not a whole number, selection of a serum sample of the proper size, in this instance 0.16 ml, simplified the final calculation. The result, expressed as mg of cholesterol in 100 ml of blood, is obtained by multiplying the L value by 1000. Similarly, the second standard, if needed, is set at 56¼ giving an L value of 0.250. Since the color developed is not entirely stable, each standard is replaced in the instrument at regular intervals and the setting readjusted to maintain the standards at the desired L values. Marked change in readings or lack of consistency in the color developed by the standards would preclude use of the simplified method, although the same objection would apply to results obtained by conventional procedures.

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[1] The technical assistance of Misses Jane Bourne and Rhoda Greenberg is acknowledged with thanks. The paper includes several helpful suggestions made by Dr. J. Harold Austin.

The accuracy obtained will depend on the extent to which the readings of the standards deviate from the desired scale values and the consequent extent of the shutter or galvanometer adjustment. It has been possible to select filters or alter sample sizes so that this deviation was kept to less than 5 mg per 100 ml for blood sugar, 1 mg per 100 ml for blood urea N, and 0.1 g per 100 ml for serum protein in a range of values ordinarily encountered. If the instrument adjustment required is appreciable, error will increase in proportion (1) as zero is approached, and (2) as the difference between concentration of the unknown and that of the standard increases.

Application of this method of calculation does not necessarily require that standards be included with each run. In clinical laboratory procedure, however, this is desirable regardless of the system of calculation employed, particularly when equilibrium reactions like those involved in blood sugar determinations are utilized.

The method described deviates partially from the accepted principles of photometry and any new applications should be thoroughly tested. Furthermore, it deliberately introduces an approximation and thus should be used with discrimination. However, it is suitable for many purposes and has proven to be of great convenience where large numbers of analyses are required in a minimal period as in the clinical laboratory. Here it has expedited analyses and decreased the number of errors arising in calculation of results.

The simplified procedure has been applied to determinations of blood sugar, urea nitrogen, serum total protein, and free and esterified cholesterol. The results in each instance have agreed closely with those obtained by the standard method of readings. Differences have been small and without statistical significance.

The Separation of Purine and Pyrimidine Bases and of Nucleotides by Ion Exchange

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As a prelude to tracer studies on the enzymatic formation and degradation of nucleic acids, we have undertaken to develop ion exchange techniques for the separation and analysis of the various bases, nucleosides, and nucleotides at the milligram level. Although this technique is finding increasing application in biochemical studies for separation of these compounds (*8, 9*) and others (*1, 2, 6, 7*), we were led independently to its use through our earlier experience with radioisotope separation by ion exchange chromatography (*4, 11*). The present note describes briefly methods we have developed for the separation of each of the purine and pyrimidine bases and of the ribose nucleotides.

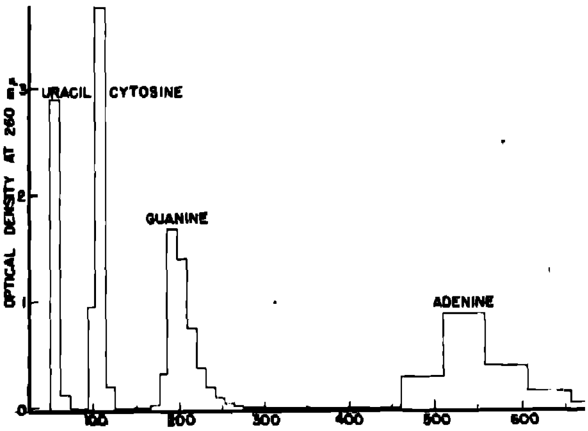

FIG. 1. Separation of purine and pyrimidine bases by cation exchange. *Exchanger*: 8.1 cm × 0.74 cm² Dowex-50, ca. 800 mesh, H⁺ form. *Eluting solution*: 2*N*-HCl at 0.6 ml/min. *Test material*: 0.5 mg uracil, 1.0 mg each of adenine, guanine, and cytosine, in 7.5 ml 2*N*-HCl. *Recoveries*: 98.5–101.5% (based on optical density at 260 mμ).

Of the five naturally occurring purine and pyrimidine bases, three (cytosine, guanine and adenine) exist as cations in solution of pH < 4 and hence are able to combine with cation exchangers. Since their affinities for the cation exchanger differ, they may be eluted successively with such simple reagents as HCl or NaCl; this is demonstrated in Fig. 1. This procedure does not separate

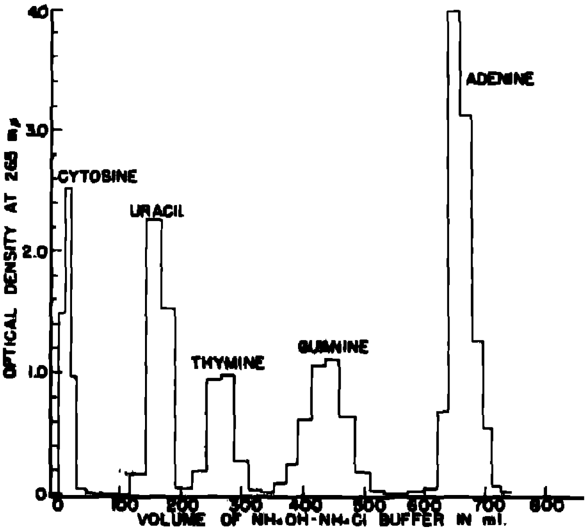

FIG. 2. Separation of purine and pyrimidine bases by anion exchange. *Exchanger*: 8.5 cm × 0.74 cm² Dowex-A1, ca. 800 mesh, Cl⁻ form. *Eluting solution*: 0.2*M*-NH_4OH-NH_4Cl buffer, pH 10.6, 0.025 *M*-Cl^- (at 575 ml, pH changed to 10.0, Cl^- to 0.1 *M*), at 0.25 ml/min. *Test material*: 1 mg cytosine, 2 mg each of other bases, in 10 ml eluting solution. *Recoveries*: 97.5–99% (based on optical density at 265 mμ).

the non-ionized bases, thymine and uracil. Since these will not usually be encountered together, no disadvantage attaches to this fact, but it is easy to separate them, as well as the other three substances, by resorting to anion exchangers[1] and alkaline solutions as shown in Fig. 2.[2] Recoveries by both procedures, based on spectrophotometric absorption in the ultraviolet (260–265 mμ) are essentially quantitative. Identification of components was made by the shape of the ultraviolet absorption curve and by partition chromatography (*3*).[3]

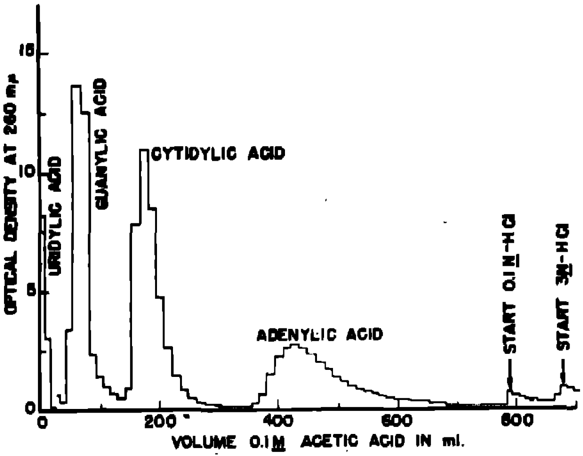

FIG. 3. Separation of mononucleotides of yeast nucleic acid by cation exchange. *Exchanger*: 24 cm × 0.74 cm² Dowex-50, ca. 300 mesh, H⁺ form. *Eluting agent*: 0.1 *M* acetic acid at 0.15 ml/min. *Test material*: 100 mg mixed nucleotides, recovered from their Ba salts following 0.6*N*-Ba(OH)$_2$ hydrolysis of yeast nucleic acid (conversion of nucleic acid to mononucleotides not quantitative), in 10 ml 0.1 *M* acetic acid. *Recoveries*: 85–100% (based on optical density at 260 mμ).

The nucleotides of yeast nucleic acid (uridylic, cytidylic, guanylic and adenylic acid) exhibit to some degree the basic properties of the purine or pyrimidine constituent; this is modified by both size and the negative phosphate group with the result that the exchanger-to-ion bond is considerably weaker. Weak acids have been found to be the most practical eluting agents and a separation by means of dilute acetic acid is demonstrated in Fig. 3. Recovery of the starting material, based upon absorption at 260 mμ, varies from 85 to 100%. In the absence of pure starting materials (the commercial preparations showing 5–50% impurity by these methods), it is difficult to do better than this without an extensive series of preparations of pure compounds. It is possible that there is a significant amount of acid hydrolysis of purine nucleotides occurring during their stay in the exchanger bed but we have not been able to prove this conclusively. Regardless of this possibility, the method as it stands will isolate the bulk of each constituent in spectrophotometrically pure form.

Concentration and metathesis of the large volumes collected in the separations are easily achieved (*5*, *10*), where evaporation is undesirable, by recycling the effluent through the same column, washing with water to remove residual acid or base, and then eluting with a reagent which removes the adsorbed ion rapidly (e.g., NH$_4$OH in the acid separations).

Although the separations reported are all at or near the milligram level, we have been able to effect practical separations on the same size columns on up to nearly 100-mg amounts. The lower limit is, of course, set by the limit of detection. At the higher levels, overlapping of bands becomes more prominent because of the relationship between the concentration of an ion and its distribution coefficient (*12*).

The details of these and related separations, with examples of their application to specific problems, will be reported elsewhere.

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[1] The Dowex-A1 anion exchanger, a strong base, was kindly furnished us by Dr. L. Matheson of the Dow Chemical Company, Midland, Michigan.

[2] These experiments were carried out by Mr. J. X. Khym.

[3] We are indebted to Dr. C. E. Carter not only for the chromatographic analyses but also for continued encouragement and assistance during the course of these experiments.

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A Simplified Procedure for the Analytical Extraction of Lipids[1]

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Recently Hsiao (*3*) described a procedure for the extraction of lipids from fish tissues. When this procedure was applied to pulverized, moist, mouse muscle tissues certain difficulties were encountered. The tissues clumped, adhered to the walls of the extraction tube, and did not disperse during the extraction period, thus interfering with complete extraction.

In order to circumvent these difficulties, to expedite the extraction of comparatively large numbers of samples, and at the same time to attain the fine state of division recommended by Bloor (*1*) the following procedure was developed.

The method of preparation of the tissue for extraction is that of Floyd (*2*) and Singher (*6*). A glass

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[1] Aided by a grant in memory of Mary Frances Sarkisian.

mortar with pestle is placed in an evaporating dish, and surrounded by and filled with solid carbon dioxide; after thorough cooling of the mortar and pestle, the dry ice is removed from the mortar. The excised tissue, which has been stored in vials over dry ice, is thawed just enough so as to be transferable to the mortar, and dry ice equal to about three times the volume of the tissue is then added. When the tissue is again frozen solid, the mixture is ground until a fine homogeneous powder is obtained. Small bits of dry ice are, if necessary, added during the grinding. The ground powder is then transferred to a vial and the carbon dioxide allowed to evaporate until a pasty mass is obtained. As soon as this change has taken place the tissue is again frozen solid.

Samples of approximately 200 mg of the partially thawed ground tissue are weighed into 50 ml conical centrifuge tubes equipped with a 24/12 Ŧ outer joint.[2] The tube is hung on a balance by an easily made support (*4*). Five ml of 95% ethanol is added and the tube is stoppered and allowed to stand until the entire series of samples have been weighed (usually 6 or 12 samples). The samples are then thoroughly dispersed with the aid of a stirring rod, and sufficient alcohol is added to each tube to wash down the walls and the stirring rod so that a total of 10 ml of solvent is used for each 200 mg of moist sample.

Pyrex #2480 Allihn condensers (200-mm jacket, 19/38 Ŧ joints) are connected to the centrifuge tubes by special adapters. These adapters are provided with an inner 24/12 Ŧ joint and an outer 19/38 Ŧ joint.[3]

The heat source is an electric digestion furnace as described by Miller and Miller (*5*). Rate of boiling may be controlled by using either a variable transformer or by adjusting the height of each tube above the heating element. When the 10-min boiling period is completed, the extraction unit is raised from the heater. After cooling to room temperature, contents of the tubes are swirled to wash down solids that creep up the walls during extraction. After centrifuging 10 min at 3,000 rpm, the clear supernatants are decanted into tared aluminum weighing dishes (Fisher Scientific Co. #8-732). The dishes with contents are placed in a desiccator over calcium chloride under moderate vacuum. The extraction is repeated with an additional 10 ml of ethanol and the resulting supernatants are added to the dishes.

In order to insure complete dryness, the residues are placed on the following day into another desiccator over fresh calcium chloride under high vacuum.

If dispersion during boiling is thorough, the second extraction does not yield more than about 3% of the weight of residue resulting from the first extraction.

Eighteen samples in duplicate of normal and cancer tissue of mice were extracted, with an average difference of 2% between the results of pairs. The average sample weight used was 224 mg, and the evaporation residues ranged from 9.5 to 14.9 mg.

The following additional information may be obtained from a series of extractions. If the insoluble residue is dried in the centrifuge tube at 100° C overnight and weighed, the sum of the weights of the soluble and insoluble portions will give a value which agrees with that of independent drying experiments on the whole tissue (100 ± 3%). When this insoluble residue is ashed overnight in the centrifuge tube at 450°, and the resulting ash weighed, a correction for soluble ash can be obtained provided the total ash is known. The soluble ash in our series was 58 ± 5% of the total ash or 14% of the evaporation residue.

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[2] These versatile centrifuge tubes may be obtained by special order from either Ace Glass, Vineland, New Jersey, or Corning Glass Works, Corning, New York.

[3] Made by J. F. Uhrig, 4104 North Fifth Street, Philadelphia 40, Pennsylvania.

Evidence that Amputation of Bacterial Flagella Does Not Affect Motility

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In previous papers (*5, 6, 8, 10, 11, 12*) the somewhat revolutionary theory was proposed that the motile bacteria which are commonly credited with flagella do not move by means of such flagella, but by means of undulating gyrating contortions of their spiral-shaped bodies. Bacterial flagella would then have to be regarded, not as motor organs, but as mucous twirls peeled off from the mucous capsule, through the very movement of the bodies.

Acceptance of this theory would have far-reaching consequences. When applied to bacteria, the word "flagellum" (which means "whip") would have to be invested with quite a new meaning, or else be given up and replaced by something like "mucous twirl." "Bacillus" and "bacterium" (meaning "rod") would become misnomers in many instances, because although a rod need not be straight, an object which definitely has the shape of a spiral, or rather coil, cannot reasonably be termed a rod. Apart from nomenclature, the new theory would obviously affect classification in a fundamental manner. This might, however, at the same time lead the way to a phylogenetic classification. Teachers might like the new theory, for with less emphasis on the appearance and importance of "flagella," irksome "flagella staining" might be given up!

Notwithstanding my several publications on the subject, and the production of a cinemicrographic film in which the new ideas are worked out step by step,[1] the new theory has received scant attention. Stuart Mudd (*4*) merely stated that it was not so. With the exception of the new edition of Zinsser's *Textbook of bacteriology* (*14*), which gave it "honorable mention" in the form of a very adequate description, bacteriologists seem reluctant to make up their minds. Conn and Elrod (*2*) have published some criticisms, mostly based on electron photomicrography with its unavoidable artifacts, but they left most of my arguments unanswered, and in their final summing up the question was still not settled. Van Iterson (*16*) based her criticism mostly on electron micrographs of the large spirilla, like *Spirillum volutans*, and I have just been able to show (*13*) that in this particular group of microbes the supposed flagella are of an unusual kind and have nothing in common with those of what are usually termed motile bacteria. The new edition of Bergey's Manual (*1*) and the new textbook of Frobisher (*3*) avoid all reference to my divergent views. Tanner and Tanner (*15*) in the new edition of their textbook mention the possibility of "a contractile membrane, or a snake-like movement" in motile bacteria, but at the same time they copy a drawing which shows *Salmonella typhosa* surrounded by more than a hundred flagella. This is of course in keeping with the old belief that motile bacteria "lead a double life," one inside the cell wall and another one outside it, unless one subscribes to the still stranger assumption that a cell wall may be pierced by flagella in more than a hundred places.

In this note I bring a further argument, based on a recent experiment, in support of the new theory.

By using my *sunlight* dark ground technique (*7*, *9*) I have shown that *Salmonella typhosa* (chosen because it is a typical representative of motile bacteria) when grown in suitable broth, exhibits a long thin tail when it is moving fast (Fig. 1). This tail can be seen on occasion to untwist itself into a number of wavy threads which arrange themselves in irregular fashion around the bacterial body and then after a while float away or disappear. All this is illustrated in the motion picture mentioned before. Their appearance and arrangement correspond to the traditional pictures of stained peritrichous flagella and the supposed flagella of electron micrographs. Obviously then, the tails of Fig. 1 are twisted bundles of what are commonly called bacterial flagella, and if these "flagella" were motor organs then the tail would be a motor organ.

On a previous occasion (*10*) I have shown that *Salmonella typhosa*, when grown in unsuitable broth or in simple peptone water, does not *show* tails and yet is perfectly motile. From this it would seem to follow that motility is not dependent on the presence of the tail, or in other words, that *Salmonella typhosa* can propel itself without outside motor organs. As a counterargument one might say that in such unsuitable culture media the tail might have become too thin to be visible. I have therefore this time gone a step further and taken a culture of *Salmonella typhosa* in suitable broth, wherein nearly every individual was very motile and showed a good tail in the sunlight dark ground microscope, and then I have literally taken off the tails. This can be done by subjecting a portion of the culture to vigorous shaking for 15 minutes. The apparatus used was a Griffin & Tatlock Microid Flask Shaker, and it really vibrates more than it shakes. After this treatment the culture was again examined under the microscope; practically all the tails had disappeared but motility was as good as before the treatment, and as good as in the untreated portion, which still showed excellent tails. The bacteria in both portions exhibited their curious gyrating, undulating movement, which shows that during active life they are spiral-shaped, and evidently this movement is quite adequate to propel them. The whole experiment was repeated six times on different cultures, always with the same result.

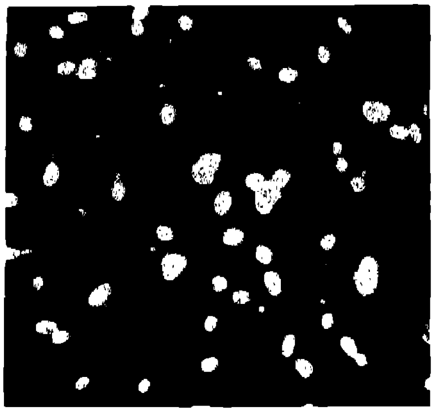

FIG. 1

The fact that one can, as it were, amputate the so-called flagella from motile bacteria and not interfere with their motility shows conclusively that such "flagella" are not motor organs.

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[1] This motion picture is available from Prof. Harry E. Morton, Chairman of the Committee on Materials for Visual Instruction in Microbiology, Society of American Bacteriologists, University of Pennsylvania, School of Medicine, Philadelphia 4, Pennsylvania.

A Simple Technique for Continuous Registration of Blood Flow[1]

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Department of Pharmacology of the University of Michigan, Ann Arbor

Methods used in research laboratories for recording blood flow such as thermoelectric flow meters, the rotameter, and the photographically recording differential manometer, are either too complex or too delicate for use in student laboratories. The bubble flow meter, while simple, has the disadvantage of giving point determinations rather than a continuous record. For purposes of demonstration or student laboratory experiments we have adapted a technique described by Fleisch (*1*), to permit registration on smoked paper. Although no original principle is involved, the following description is offered in the belief that others may find the instrument useful.

As first described, a closed U-tube containing dyed chloroform was used for recording the pressure drop across a stainless steel cannula (*2*). Kymographic records were obtained by following the water-chloroform meniscus manually by means of a pointer attached with thread to a recording stylus. In its present form, a membrane differential manometer is arranged to inscribe directly on the drum.

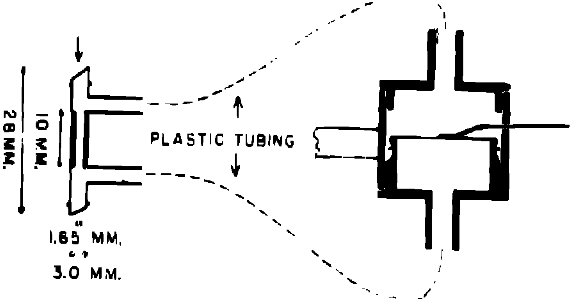

FIG. 1. Cannula and manometer drawn to same scale. Internal diameter of cannula at constriction, 1.65 mm.

The cannula is made of stainless steel; the inner surface is polished and coated with a silicone preparation. The dimensions given in the diagram (Fig. 1) are suitable for recording femoral arterial flow in dogs of 12 to 18 kg. The ends of the cannula are tied centrally and peripherally into the femoral artery; since blood is not diverted from the animal no warming device is required. The side tubes are connected through transparent plastic tubing to the brass manometer capsule. A short segment of rubber tubing attached to the distal side tube of the cannula permits introduction of a fine hypodermic needle directly into the blood stream.

The manometer capsule consists of a central cylinder threaded to receive the two end pieces, one serving as a tambour and the other as a cap. The tambour piece, fitted with dental dam tied in place with very little tension, is screwed into the cylinder. Stopcock grease applied to the threads ensures a water-tight seal. A short piece of wire is inserted through the fulcrum hole in the side of the cylinder, and the flattened end is cemented to the center of the rubber membrane with an aqueous-base latex suspension. The fulcrum is sealed off from the inside with several coats of the same cement, care being taken to obtain a water-tight joint, while allowing adequate flexibility for the movement of the lever arm. The cap is then screwed into place, and the instrument is filled with saline solution. A light pointer about 20 cm long is attached to the projecting end of the wire lever arm. In use, the capsule should be mounted cap down so that the weight of the lever presses the inner end up against the membrane.

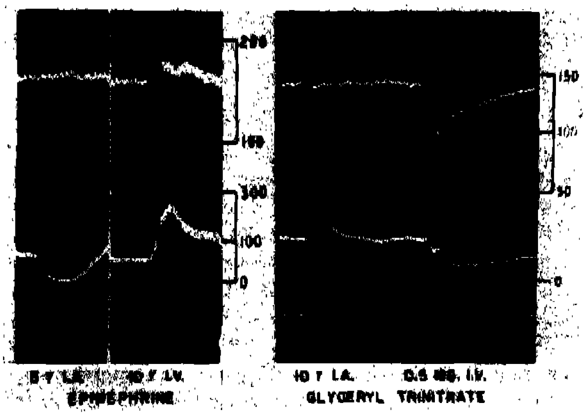

FIG. 2. Records of arterial pressure (above) and femoral arterial flow (below); two experiments. Epinephrine (left) and glyceryl trinitrate (right) were injected intra-arterially and intravenously. The upper scale represents pressure in mm Hg; the lower, blood flow in cc/min. Time signal: left tracing, 10 sec; right tracing, 1 min.

The cannula itself needs to be calibrated only once. This is done by passing blood at body temperature through the instrument and recording the pressure differential at various rates of flow by means of a closed U-tube containing chloroform under water. It should be recalled that 1 cm difference in height between the two chloroform menisci is equivalent to approximately 0.5 cm of water. The manometer capsule can then be calibrated when desired by applying a measured pressure differential to the two outlets. In our experience, at low flows the calibration curve approximates that predicted from the Poiseuille equation. At higher flows the pressure difference exceeds that predicted by the equation.

Heparinization of the animal is of course necessary. We have used a priming dose of 2 to 3 mg/kg, followed by continuous infusion of about 2 mg/kg/hr.

Records of arterial flow and pressure obtained in class demonstrations are illustrated in Fig. 2.

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[1] Development of this apparatus was begun when the author was at Harvard Medical School and was completed at the University of Michigan.

Inhibitor in Onion for Starch Synthesis

H. C. Eyster

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Most plants store starch in the chloroplasts of the leaf following photosynthesis. The main exceptions are members of the lily, iris, amaryllis, and gentian families (*1, 2*). Onion is a member of the lily family.

Leaves are also able to absorb some sugars such as glucose, fructose, maltose, and sucrose, and transform them into starch. Leaf squares of etiolated corn floating on sugar solutions form an abundance of starch. It is in this way that the starch-forming mechanism in plants can be studied.

Juice from bulbs of cultivated onion as well as from leaves of wild onion (garlic) prevented the formation of starch in leaf squares of corn. The juice was extracted by means of a Carver laboratory press and added to a 1 M glucose or sucrose solution in equal amounts making the final concentration of juice 1: 2 and the sugar solution one-half molar. The control was set up by mixing the juice with an equal volume of water. The total amount of solution used was 15 ml in Petri dishes which had a total capacity of about 30 ml. At the end of 24 hr, leaf squares were tested for the presence of starch by first boiling them for a minute in water, second, extracting the yellow pigments in 95% ethanol, and finally applying a dilute solution of iodine (I_2KI) to the leaf squares spread out on a glass plate. The presence of starch in the control was indicated by a dark coloration.

TABLE 1

FORMATION OF STARCH IN LEAF SQUARES OF ETIOLATED CORN FLOATING ON .5 M GLUCOSE SOLUTIONS WHICH CONTAINED JUICES OF PLANTS NOT NORMALLY STORING STARCH

Plant	Starch test	
	Juice diluted 1 : 2	Juice diluted 1 : 15
No juice added (control)	Strong positive	Strong positive
Hemerocallis fulva (day lily)	Negative	Trace
Narcissus Jonquilla (jonquil)	"	Negative
N. Pseudo-Narcissus (daffodil)	"	Slight trace
Allium Cepa bulbs (onion)	"	Small positive
A. canadense (wild garlic)	"	Trace
Frasera carolinensis (American columbo)	Trace	....
Iris versicolor (iris)	Small positive	Strong positive

Plants related to onion such as the day lily (lily family), jonquil and daffodil (amaryllis family), and American columbo (gentian family) also have the inhibitor (Table 1). Wild onion (garlic) leaves have a somewhat more potent concentration of the starch-forming inhibitor than the bulbs of the cultivated onion. Iris didn't seem to have much inhibitor. The test was made in midsummer and the result on iris may have been due to the time of year when the plant juice was tested. Day lily juice tested in summer had much less inhibitor than in spring, so there is a seasonal variation.

Juice from plants such as dandelion, wild carrot, wild strawberry, corn, and tomato which do store starch did not inhibit the formation of starch in the leaf squares of etiolated corn (Table 2). Juice from alsike clover and red clover did have a slight inhibitory effect in dilutions of 1: 2. While alsike clover and red clover do store starch, the slight inhibitory effect of the juice on starch formation in leaf squares of etiolated corn is as yet unexplainable.

TABLE 2

FORMATION OF STARCH IN LEAF SQUARES OF ETIOLATED CORN FLOATING ON .5 M GLUCOSE SOLUTIONS WHICH CONTAINED JUICES OF PLANTS NORMALLY STORING STARCH

Plant	Starch test	
	Juice diluted 1 : 2	Juice diluted 1 : 15
No juice added (control)	Strong positive	Strong positive
Taraxacum officinale (dandelion)	" "	" "
Zea Mays (corn)	" "	" "
Fragaria virginiana (wild strawberry)	" "	" "
Daucus Carota (wild carrot)	" "	" "
Lycopersicon esculentum (tomato)	" "	" "
Trifolium hybridum (alsike clover)	Small positive	" "
T. pratense (red clover)	Small positive	" "

Dilution of the juice from cultivated onion bulbs showed inhibitory influence during the first day up to dilutions of 40 to 80 times. Most or all of the effectiveness of the inhibitor seemed to be lost during the second day in cases where the juice was diluted more than 10 times.

The inhibitor of starch synthesis is not entirely heat stable nor is it entirely decomposed by heating to the boiling point momentarily and then cooling.

Day lily leaves do not form starch in the leaves under natural conditions. If leaf squares of the day lily are floated on .5 M glucose in the dark at room temperature, starch begins to form at the cut edges at the end of the second day. This is in accordance with Böhm who showed that some plants in which no starch is formed, e.g., *Galanthus*, *Hyacinthus*, *Ornithogalum*, and *Iris*, can be induced to starch formation when the leaves are kept on a 20% solution of sucrose for 8–10 days (*2*). These plants have the mechanism for starch formation but do not form it under natural conditions, apparently because of the presence of an inhibitor.

Members of the lily, iris, amaryllis, and gentian families do not store starch in the leaves following photosynthesis, apparently because of the presence of a starch synthesis inhibitor. Onion, a member of the lily family, has the inhibitor.

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The Isthmic Mucous Membrane of the Human Uterus

D. N. Danforth and James C. F. Chapman

Departments of Obstetrics and Gynecology, and Pathology, Evanston Hospital, Evanston, and Northwestern University Medical School, Chicago

The purpose of this report is to present preliminary findings in a study of the mucous membrane lining the isthmic segment of the human uterus. These findings indicate that the isthmic mucosa is not peculiar, as it has been extensively described, but that, rather, it is an integral part of the corporeal endometrium.

According to current understanding, the isthmic mucosa is an entity in itself, separate and distinct from that of the cervix and corpus. A similarity with the endometrium is recognized, however, with the following exceptions: the isthmic mucosa is described as being thinner, poorer in glands, and richer in supporting tissue. Also, its glands are said to react poorly to the ovarian hormones, and to contain no glycogen during the secretory phase. A further difference is the reported absence of coiled arterioles, which are a prominent feature of the endometrium. The conclusion from these observations is that although the two tissues casually resemble one another, nevertheless they are fundamentally dissimilar.

Preliminary studies have been made of the mucous membrane of 38 human uteri removed at operation. The endometrial cycles were distributed as follows:

Early proliferative	6
Late proliferative	12
Early secretory	6
Late secretory	10
Post-menopausal	4

In each of these cases, similar blocks of the isthmic mucous membrane were prepared for comparison with the endometrial specimens.

Comparison of the endometrial functionalis with the isthmic mucosa confirms the observations noted above. However, when the endometrial basalis is examined in routine hematoxylin and eosin sections, it is found to be essentially similar to the isthmic mucosa. The basalis is of the same thickness. The general appearance of the glands, and their cyclic changes in response to the ovarian hormones, are the same. The characteristics of the stroma, and the vascular distribution, are similar. Special staining technics show further evidences of similarity. One concludes from these observations that the isthmic mucosa is in fact a continuation of the endometrial basalis and that it differs from the endometrium proper only in that the functional layer is lacking.

These observations cast serious doubt upon the propriety of designating the isthmus uteri as an entity of equal importance with the cervix and corpus. They suggest, rather, that this zone is part of the corpus uteri. Details of this study will be presented elsewhere.

Physical Studies on Corneal Tissues

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S. T. Gross and J. M. Lambert[1]

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Improvements in the technique of corneal grafting have increased the interest in the proper preservation of corneal donor tissue. Many investigations have dealt with corneal metabolism (*6, 11*), permeability (*4*), transparency (*1, 8*), hydration properties (*8, 10, 12*), X-ray diffraction (*9*), birefringence (*8*), and elasticity (*13*). A number of investigators (*2, 3, 5, 7, 14*) have reported on methods for preserving corneal tissue but of these only three (*3, 5, 7*) have applied biological methods for determining the viability of the aging cornea. No attempts were made in the past to correlate physical properties of the aging cornea with the transplantability of the tissue. For this brief review only the most pertinent references have been selected from a large bibliography.

The object of our brief investigation was to find some physical properties of corneal tissue which would measurably change during aging to indicate suitability for subsequent successful transplants. The experiments were made with bovine corneas and comprised 1) quantitative light transmission measurements as well as 2) X-ray diffraction studies. The eyes were removed immediately after death of the animal, rinsed with a 0.025% isotonic buffered thyrothricin solution, transported into a sterile moist chamber, and processed at the laboratory within 1 hr. During aging, the corneal tissues were kept in a refrigerator at a temperature of 5° C.

1) *Light transmission.* Experiments were made to determine the light transmission of corneal tissue with aging under different conditions. Periodic light transmission measurements were performed on several corneas set up for simultaneous aging. A disk-shaped cellulose acetate sponge with a round opening in the center served as the

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[1] The authors gratefully acknowledge the assistance of the General Aniline and Film Corporation in making available the facilities of its Central Research Laboratory.

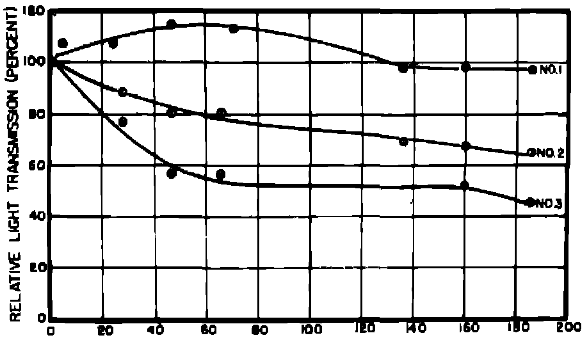

FIG. 1. Light transmission characteristics of aging corneal tissue. No. 1—in mineral oil; Nos. 2 and 3—in moist chamber.

support for the cornea. The auxiliary equipment consisted of a stabilized incandescent light source with a condensing system for producing a parallel beam of light which, after traversing an iris diaphragm and a blue filter, passed through the cornea. The transmitted light fell on the photocell equipped with a second iris diaphragm (set to a fixed 2-mm opening) and was measured by means of a photometer (Photovolt Model 500).

Typical results obtained with one set of bovine corneas are given in Fig. 1, showing relative light transmission values plotted against time of aging. Cornea No. 1 had been placed in mineral oil (Nujol) according to a procedure by Buerki (*2, 3*), which reportedly preserves corneal tissue for many days or even weeks; corneas Nos. 2 and 3 had been aged in a moist chamber. In the former case, Nujol was used to fill completely the chambers of the specimen holder, whereas in the latter case physiological saline solution was used merely to cover the bottom of the outer and inner chambers and to moisten the sponge supporting the specimen. The transmission values given in Fig. 1 were computed from the maximum photometer readings obtainable; relative values were obtained by assigning the value 100 to the amount of light transmitted initially by each cornea and expressing the other values in proportional units. With the first eight corneas studied, the photometric readings were not taken at maximum transmission and the results are therefore not strictly comparable.

The results obtained with two other sets of four bovine corneas, some aged in mineral oil and others in presence of saline solution as described above, were essentially like the ones presented, except for the apparent increase in light transmission shown in Fig. 1 (cornea No. 1). It is believed that a focusing effect caused by a slight mechanical deformation brought this about. In one case a cornea taken from an eye which had not been rinsed with thyrothricin solution gave the exceptionally low light transmission of 25% after about 100 hr in the moist chamber; subsequently the turbidity decreased, but this effect was probably due to bacterial attack or some other form of decomposition.

The light transmission data for corneas during aging appear to furnish a measure of their viability. Refinements of the technique might lead to the development of a method for testing corneal tissue and predicting its suitability for transplanting.

2) *X-ray diffraction.* Hertel (*9*) in 1933, using diffraction methods, carried through a very comprehensive investigation of the transparent tissues of the eye. His interest, however, was largely concerned with ultimate structure and constitution of materials available, and the effects on diffraction patterns of water content, ash constituents, etc.

In the present experiments, equipment was arranged so that corneal specimens could be maintained under conditions considered to be satisfactory for storage while the X-ray exposures were made. The camera, maintained near ice temperature, was filled with a fine mist of physiological salt solution to insure against moisture changes of any importance. Two samples each from four corneas were used.

Fresh corneas yielded diffraction patterns essentially identical to those published by Hertel for his fresh material. Corneal specimens were maintained at about 2°–5° C under an atmosphere of saturated relative humidity for various periods of time previous to examination. Aging under these conditions yielded diffraction patterns which were practically identical with those from samples which had not been aged, although there were indications of slight changes in the small angle scattering region. Samples preserved in mineral oil (*2, 3*) gave patterns equivalent to those indicated above, even when the sample was slightly hazy.

Air-dried samples and samples dried by immersion in successively more concentrated solutions of ethyl alcohol (from 30 to 100%) gave diffuse patterns quite similar to those of undried material, even though the sample turned opaque. Probably in this case the epithelium and endothelium were responsible for the appearance (*8*). Stretched samples both fresh and aged gave for the fiber period 11.2 A (Hertel finds 9.7 A) and the most intense spacing at right angles 2.85 A (Hertel finds 4.4 A). It must be concluded that the diffraction patterns furnish no evidence for degree of aging, and with the present technique cannot indicate whether an aged cornea is suitable for a successful transplant.

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Comments and Communications

Use of Modified Ninhydrin Reagent in Quantitative Determination of Amino Acids by Paper Chromatography

Procedures for the quantitative estimation of amino acids separated on paper chromatograms have been reported.[1] In this laboratory we have been able to measure quantitatively some free amino acids in tissues of the rat by a method described elsewhere (AWAPARA, J. *J. biol. Chem.*, 1949, in press). Briefly, the procedure consisted in 1) locating the amino acid spots with a 0.05% ninhydrin solution in water-saturated butanol; 2) cutting the spots from the chromatogram and developing full color with 1 ml of 2% aqueous ninhydrin solution in presence of pyridine by heating on a boiling water bath for 20 min; and 3) transferring the colored solution to a volumetric flask and measuring the color intensity in the Beckman Spectrophotometer at 570 mμ.

TABLE 1

Density Values at Various Concentrations of Amino Nitrogen

Amino nitrogen	Optical density			
γ*	Glutamic acid	Aspartic acid	Glycine	Alanine
4	0.124	0.155	0.128	0.105
8	0.343	0.318	0.277	0.218
12	0.551	0.487	0.434	0.410
16	0.741	0.665	0.621	0.555

* Values given correspond to solutions made up to a volume of 25 ml, and corrected for paper blanks.

Recently S. Moore and W. H. Stein (*J. biol. Chem.*, 1948, 176, 367) have reported a modified ninhydrin reagent. They used a 2% ninhydrin solution in methyl cellosolve water at pH 5 (citrate buffer), which contained stannous chloride as a reducing agent. We have used this reagent instead of ninhydrin pyridine solution and obtained more consistent results and higher intensity of color. The intensity was found to increase considerably when larger amounts of reagent were used, up to 3 ml. Amounts greater than 3 ml were found to give constant values.

Table 1 shows density readings obtained at various concentrations for solutions of glutamic acid, aspartic acid, glycine, and alanine. In all cases the color intensity is a straight line function of the concentration. The greatest source of error in this procedure is the filter paper, which gives blank readings ranging from 0.070 to 0.100. This range of 0.030 units indicates an error of about 7% when 10 γ of amino nitrogen are being determined. The reproducibility of analyses carried out on the same sheet of paper is, however, very satisfactory with variations of about 1 to 2%. Best results were obtained when an aliquot of the colored solution was removed from the tube and made to a convenient volume. By this procedure, the difficult removal of all the color on filter paper remaining in the tube was avoided. The amount of color adsorbed on filter paper was constant.

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University of Texas,
M. D. Anderson Hospital for Cancer Research

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[1] AWAPARA, J. *J. biol. Chem.*, 1949, in press; FISHER, R. B., PARSONS, D. G., and MORRISON, G. A. *Nature*, 1948, 161, 764; NAFTALIN, A. *Nature*, 1948, 161, 763; POLSON, A., MOSLEY, V. M., and WYCKOFF, R. W. G. *Science*, 1947, 106, 603; and WOIWOD, A. J. *Nature*, 1948, 161, 169.

More on High School Biology Requirements

Dr. J. van Overbeek's apprehensions as to the effects of the inadequate teaching of the biological sciences in the secondary schools of this country (*Science*, 1949, 109, 210) are undoubtedly shared by a good many other biologists. I certainly agree that more adequate instruction in biology is needed in most of our secondary schools. However, Dr. van Overbeek's suggestion that we emulate the admirable Dutch program and require a course in biology in each year of high school is highly impractical. While he might have no difficulty convincing me and other biologists that this would be desirable, he would have little success in convincing most of those educators who are responsible for the secondary school curricula throughout the country. He would first have to convince them that *one* year of biology should be required of all high school students. At present many students are graduating from high school with nothing more in the way of science than a single (and usually inadequate) course in general science. It seems that the trend has been to reduce, rather than to increase, the science requirements for graduation from secondary schools.

Even if Dr. van Overbeek were successful in his efforts to have three or four years of biology required for graduation from high school, the program would fail through lack of qualified instructors. There are not even enough qualified biology teachers to handle the high school biology courses now offered. While there are many excellent teachers of high school biology scattered throughout the country, I believe it is safe to state that the majority, even in large cities, have so little training and interest in the subject that they almost waste their students' time. The prospects of an improvement in this situation are not encouraging. As all college and zoology professors know, their better and more capable majors go on to graduate school and eventually into research or college teaching.

Superior students are encouraged to do this, and perhaps rightly, but the result is that there are not very many really good high school biology teachers. This situation has apparently concerned most professional biologists very little, but I believe that there are now many who will agree with Dr. van Overbeek as to the importance of a biologically literate public and the role of the secondary schools in producing it.

Professional biologists, through their various societies, might well support a program designed to improve the quality and quantity of secondary school biology. While there may be little hope of attaining the goals set by Dr. van Overbeek, I think that substantial progress could be made toward securing the more general requirement of a year of biology for graduation from high school, and toward the improvement of these high school biology courses and the recruiting of more capable and interested teachers for them.

I believe that professional scientists might also take a greater interest in supporting and encouraging the extension of the excellent elementary school science programs which have been established in some cities. It is quite possible that good elementary school science instruction can have a more thorough and lasting influence than secondary school science instruction in developing a public with an interest in and appreciation of science and its methods, attitudes, and problems of general concern. Here again, one of the principal difficulties is adequately trained teachers.

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Agricultural and Mechanical College of Texas

Errata

My attention has been drawn by correspondents to two incorrect statements in my article "Research and Politics" (*Science*, March 4, 1949). First, it was stated that Vavilov died in a concentration camp. This should have read "died in exile in a remote region of the USSR," since the details are unknown. Second, I said that Kammerer committed suicide after going to Russia. Actually, he did so while still in Vienna, at the moment when he was finally to move to Moscow.

RICHARD B. GOLDSCHMIDT
University of California, Berkeley

I would like to call your attention to an error that crept into the paper on neomycin by Waksman and Lechevalier (*Science*, March 25). On page 307, right column, lines 1, 8, and 9, the letter μ should read *u*, or *unit*.

SELMAN A. WAKSMAN
Department of Microbiology, Rutgers University

In the paper "The Effect of Choline-Deficiency on Uterine Activity of Rats," by Kraatz and Gruber (*Science*, March 25), the tenth line from the end, p. 312, ". . . choline every second" should be amended to read ". . . choline every second day."

CHARLES P. KRAATZ
Department of Pharmacology, Jefferson Medical College

(Continued from page 376.)

a plausible straight line is obtained which has an intercept on the $y+R$ axis of value R since $y=0$ when $R=0$.

The value so derived for R is 14 ± 2 mμ. Careful measurements over a wider range of ionization densities are in progress. The figure agrees well with the figure 18 mμ deduced by Luria and Exner (*3*) from observations of X-ray inactivation.

The results of deuteron bombardment of T-1 phage are thus consistent with the following hypotheses:

1. A target exists, of diameter 28 ± 4 mμ which is very much smaller than the phage itself and indeed smaller than the head of the phage.
2. The measured target size is larger than the true target, due to the fact that radiation from the path of a deuteron which misses the target can inactivate the phage.

References

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NEWS and Notes

ACS at San Francisco. More than 3,500 chemists and chemical engineers participated in the **115th national meeting of the American Chemical Society** held in San Francisco March 28–April 1. Advances in fields ranging from the biochemical approach to genetics to the application of chemical engineering techniques in the control of air pollution were reported in 670 papers at sessions of 17 professional divisions of the Society.

The need for more teamwork among scientists of all disciplines in dealing with the increasingly complex problems encountered on the research frontiers today was emphasized by Arne Tiselius of Sweden, 1948 Nobel Prize winner in chemistry, at a general assembly of the Society. Professor Tiselius described "Some Trends of Development in Present Day Biochemistry."

Selection of Arthur B. Lamb, of Harvard University, for the past 30 years editor of the *Journal of the American Chemical Society*, to receive this year's Priestley Medal was announced at the general session. Professor Lamb, who was cited for outstanding services to chemistry, will retire from his editorial post at the end of this year.

Names of the winners of eight other awards administered by the Society also were announced by Linus Pauling of the California Institute of Technology, president of the Society. They are: Garvan Medal—Agnes Fay Morgan, chairman of the Department of Home Economics, University of California, Berkeley; American Chemical Society Award in Pure Chemistry (financed by Alpha Chi Sigma)—Richard T. Arnold, University of Minnesota; Borden Award in the Chemistry of Milk—George R. Greenbank, U. S. Department of Agriculture, Bureau of Dairy Industry; Eli Lilly and Company Award in Biological Chemistry—Irving M. Klotz, Northwestern University; Paul-Lewis Laboratories Award in Enzyme Chemistry—Henry A. Lardy, University of Minnesota; Fisher Award in Analytical Chemistry—G. E. F. Lundell, retired chief of the Chemistry Division, National Bureau of Standards; Fritzsche Award in Essential Oils—John L. Simonsen, Imperial Institute, South Kensington, London, England; and Precision Scientific Company Award in Petroleum Chemistry—B. H. Sage, California Institute of Technology. All the awards will be presented at the Society's fall meeting in Atlantic City, New Jersey.

Two symposia sponsored by the Division of Biological Chemistry were among the outstanding sessions on the San Francisco program. At a meeting on viruses, Albert P. Krueger and associates, of the University of California, reported that bacteriophage, the mysterious germ-killer produced by bacteria themselves, has for the first time been made artificially in the absence of living cells. At the symposium on the relation of genetics to biochemistry, Daniel Mazia, University of Missouri, reported evidence indicating that the innumerable variations of physique and character distinguishing each man from all others may result from immeasurably small differences in a single body chemical—desoxyribonucleic acid, a component of genes and chromosomes.

The first practical synthesis of an antibiotic drug was reported at the meeting. Chemists of Parke, Davis and Company told the Medicinal Division of finding methods of making artificial chloromycetin. Discovery of an unidentified substance which may be responsible for high blood pressure in human beings was announced by Henry A. Schroeder of the Washington University School of Medicine.

Development of air pollution standards for Los Angeles, which may prove applicable to industrial cities everywhere, was announced by Louis A. McCabe, head of the Los Angeles Air Pollution Control District. Several new insecticides were described, among them a material known only as Compound 497—said to be many times as effective as DDT against roaches and houseflies. At the same session, devoted to "Economic Poisons," warnings were sounded against the potential health hazards presented by the powerful new pest-killers.

The purity of water used for irrigation purposes, new findings concerning the path of carbon in photosynthesis, and the application of microanalytical methods to petroleum chemistry were among the other subjects discussed at the meeting.

WALTER MURPHY

W. C. Davison, dean of the Duke University School of Medicine, has been appointed a consultant to the U. S. Army Surgeon General, and will serve his first month's duty in Tokyo. Returning from Japan, he will stop in Shanghai for a week to conduct clinics in pediatrics for the American Bureau for Medical Aid to China.

Francis W. Reichelderfer, chief of the U. S. Weather Bureau, has been named vice president of the American Geophysical Union of the National Research Council, to fill the unexpired term of Harald U. Sverdrup, who has returned to Norway. The term expires June 30, 1950.

Floyd Firestone, consulting physicist and editor of the *Journal of the Acoustical Society*, has been named program director of underwater acoustics research for the Office of Naval Research.

Roland McKee, Division of Forage Crops and Diseases, U. S. Department of Agriculture, has retired after more than 43 years with the Department.

James C. Spence, professor of Child Health, University of Durham, England, will deliver the Cutter Lecture on Preventive Medicine at the Harvard Medical School May 11. His topic will be "The Role of Parents in Child Health."

J. Gilman Reid has been appointed chief of the Engineering Electronics Laboratory of the National Bureau of Standards, where he has been a staff member since 1937. He will direct research on electronic instrumentation, miniaturization, printed circuit processes and techniques, electronic circuit components, and electronic standards. Other recent appointments are **C. H. Townes**, and **P. Kusch**, both professors of physics at Columbia University, who will be consultants to the Microwave Standards Laboratory.

Ralph E. Fadum, professor of soil mechanics at Purdue University, has been named head of the Department of Civil Engineering, at North Carolina State College of Agriculture and Engineering. He will succeed C. L. Mann, who retired last fall after more than 50 years on the faculty. Dr. Fadum will take over his new duties July 1.

W. H. Twenhofel, editor of the *Journal of Sedimentary Petrology*, has been elected honorary member of the Society of Economic Paleontologists and Mineralogists.

A. L. Patterson, assistant professor of physics at Byrn Mawr, has been appointed senior member in charge of the Physics Department of the Institute for Cancer Research, Philadelphia, effective September 1.

Paul F. Sharp, former director of research, Golden State Company of California, has been appointed director of the California Agricultural Experiment Station at Berkeley. He will succeed **C. B. Hutchison** who continues as professor of agriculture, dean of the College of Agriculture, and vice president of the University of California.

Morris Schaeffer, assistant professor of pediatrics at Western Reserve University School of Medicine, and director of the Cleveland City Hospital Contagious Department, has been appointed director of the Virus and Rickettsial Research and Epidemiology Branch of the Communicable Disease Center, U. S. Public Health Service, effective June 30.

Frank A. Hartman, research professor of physiology, Ohio State University, has returned after spending three months at the Barro Colorado Island Laboratory in the Panama Canal Zone, and in western Panama, collecting and studying adrenals of birds and other vertebrates.

A. C. Smith, Smithsonian Institution botanist, has been appointed a vice president of the taxonomy section of the Seventh International Botanical Congress, to be held in Stockholm next year, and Roy E. Clausen, Berkeley geneticist, will be a vice president of the section on genetics.

B. N. Uppal, former principal of the College of Agriculture, Poona, India, has been appointed director of agriculture for Bombay Province.

Visitors to U. S.

John R. E. Bradfield, Fellow of Trinity College, Cambridge University, England, recently spent two weeks studying autoradiographic techniques with George A. Boyd in the Atomic Energy Project Laboratories at the University of Rochester School of Medicine.

Raj Chandra Bose, former head of the graduate department of statistics, University of Calcutta, India, has arrived in this country to accept appointment as professor of mathematical statistics at the University of North Carolina.

Necmettin Polvin, professor of neurology at the University of Istanbul, is spending several months in the Tissue Culture Laboratory of the University of Texas Medical Branch, Galveston, in association with C. M. Pomerat, director. They are developing new methods for the growth of brain tissue in artificial media.

Grants and Awards

The University of North Carolina has received a $4,500 **Frederick Gardner Cottrell** grant from the Research Corporation of New York City for fundamental research in the structure of polymers derived from pyrones. The project will be under the direction of Richard H. Wiley, professor of chemistry.

Winners of the **Frank B. Jewett Fellowships for 1949–1950** named by the American Telephone and Telegraph Company are: Harish-Chandra, mathematician, Institute for Advanced Study; James A. Jenkins, mathematician, Harvard University; Robert Karplus, physicist, Institute for Advanced Study; Joaquin Mazdak Luttinger, physicist, Physikalisches Institut, Zurich, Switzerland; David Emerson Mann, chemist, University of Minnesota; and Harvey Winston, chemist, Columbia University. The awards grant $3,000 to the recipient and $1,500 to the institution at which he chooses to do his research. Drs. Luttinger, Karplus, and Jenkins were among the award winners last year.

The Rockefeller Foundation has recently granted $29,000 to the University of California for research on the comparative biochemistry of marine organisms, particularly animal biochromes, to be conducted under the direction of Denis L. Fox, professor of marine biochemistry, at the Scripps Institution of Oceanography. The money is to be used during a four-year period, beginning July 1, 1949, and is a renewal of a similar grant for the biennial period 1947–49.

Lawrence Tyler Post, head of the Washington University Medical School Department of Ophthalmology, has been awarded the **Leslie Dana Medal** by the St. Louis Society for the Blind, in recognition of his work with blindness.

Fellowships

Cornell University has established 16 undergraduate scholarships for students from abroad. Five will be awarded in agriculture, four each in veterinary medicine and industrial and labor relations, and three in home economics.

The New York State mental health authority has allocated funds for 10 $1,600 fellowships in social work. They will be granted, upon recommendation of the advisory mental health council, to students who have completed their first year in graduate school and who wish to specialize for their second year in psychiatric social work, in preparation for community mental hygiene or child guidance clinic work. Inquiries may be addressed to Miss Hester B. Crutcher, director of psychiatric social work, New York State Department of Mental Hygiene, Governor Alfred E. Smith State Office Building, Albany, New York.

Colleges and Universities

The University of Utrecht, Holland, is planning a series of scientific films, intended to cover the entire field of science. The first films will be on medicine. The Ministry of Education and the various faculties will contribute to production costs, and a grant has been made for the purpose by the Rockefeller Foundation.

The College of Medicine, University of Vermont, and the Vermont Association for the Crippled are jointly sponsoring a course in the diagnosis and treatment of convulsive disorders. Lectures, designed to meet the needs of the general practitioner, will be held in Burlington, Vermont, April 18–23. W. G. Lennox, of the Neurological Institute of the Children's Medical Center, Boston, will give two lectures on epilepsy.

Summer Programs

The Biological Laboratory, Cold Spring Harbor, Long Island, New York, is offering, for the fifth successive year, a summer course on bacteriophages, June 27–July 16. The course will be given by Mark H. Adams, New York University, and is designed to acquaint research workers with techniques used in work with bacterial viruses, and with recent results of such work. Further information may be had by writing the Laboratory.

Smith College School for Social Work announces its summer program of graduate seminars for experienced social workers, to be held July 11–21. Students are required to elect at least two, but may enroll for three of the following courses: advanced casework, supervisory methods in social casework, ego psychology, the psychosomatic concept, educational methods in teaching casework, and casework writing and interpretation. Each seminar is limited to 30 students, and applications should be made by *May 15*. For additional information write: Florence R. Day, director, Smith College School for Social Work, College Hall 8, Northampton, Massachusetts.

The University of Chicago will hold a workshop for research workers and teachers interested in problems of adjustment to old age, August 8–27, under the direction of Ernest W. Burgess, chairman of the Department of Sociology, and Robert J. Havighurst, of the Committee on Human Development. The University will also be host to an Institute on the Study of Old Age, August 8–12.

Meetings and Elections

Six Messenger Lectures on acoustics are being given at Cornell University, April 11–21, by Harvey Fletcher, director of physical research of the Bell Telephone Laboratories.

The Fourteenth Cold Spring Symposium on Quantitative Biology will be held June 8–16. The topic is "Amino Acids and Proteins," with emphasis on the biological aspects of the problem. Program participants will include: K. Linderstrom-Lang, from Denmark; C. Fromageot and J. Roche, from France; D. Crowfoot, J. F. Danielli, F. Sanger, and R. L. M. Synge, from Great Britain; and K. O. Pedersen, from Sweden. Attendance is restricted by space limitations to about 100. For program and information, write to the Biological Laboratory, Cold Spring Harbor, New York.

The Naval Ordnance Laboratory aeroballistics facilities at White Oak, Maryland—supersonic and hypersonic wind tunnels, and transonic and pressurized ballistics ranges—will be formally dedicated June 27. There will be five half-day technical sessions June 27–29 on general aerodynamics, ordnance aeroballistics (restricted), theoretical supersonic and transonic aerodynamics, and experimental supersonic aerodynamics at which foreign and U. S. scientists have been invited to present papers. The Fluid Dynamics Division of the American Physical Society will meet June 30 and July 1 at the Naval Ordnance Laboratory and will sponsor symposia on turbulence, shock-wave phenomena, and aerothermodynamics. Those interested in attending the dedication and technical sessions June 27–29 should write to R. J. Seeger, U. S. Naval Ordnance Laboratory, White Oak, Silver Spring 19, Maryland.

The Virginia Academy of Science will hold its 27th annual meeting at the Hotel John Marshall in Richmond, May 5–7. Final winners in the Virginia Science Talent Search will be selected, together with all winners in the Science Clubs Contests. Their names will be announced at the dinner of the Junior Academy of Science on Thursday evening by James W. Cole, Jr., of the University of Virginia, and Boyd Harshbarger, of the Virginia Polytechnic Institute, president-elect of the Academy. The dinner speaker will be Major T. F. Walkowicz, of the United States Air Force. Following his address, a sound motion picture entitled "Atomic Physics" will be shown under the auspices of the Atomic Energy Commission and the Oak Ridge Institute of Nuclear Studies.

The annual business meeting of the Junior Academy will be held at 2:00 P.M. on May 5. C. M. Kincaid, of the Virginia Polytechnic Institute, will speak on "Genetics, an Expanding Science," and Gordon Silas, of Roanoke College, will present a paper on "The Anatomy of Human Behavior."

The first meeting of the senior division of the Academy will be held Thursday evening at 8:30 o'clock. At this general conference, reports of 16 committees will be made. These reports will be published later in the 1948–1949 *Proceedings* of the organization.

Section meetings of the Academy will begin at 9:00 A.M. on Friday, May 6. Approximately 250 papers will be presented in the branches of science represented by the following Sections: agricultural sciences, astronomy, mathematics and physics, bacteriology, biology, engineering, education, chemistry, geology, medical sciences, psychology, statistics, and science teaching methods. Virginia winners of honorable mentions in the National Science Talent Search and winners in the state search will present their essays in appropriate Sections. An attendance of approximately 800 is expected for these sessions. The Section on engineering, which has not met since before the war, will be reactivated at this meeting. The program of a new Section for science teachers will be presented on May 6 and 7. Collegiate members of the Academy will hold a special session at 3 o'clock on Friday afternoon.

During the three days of the meeting about 30 educational and commercial exhibits will be shown in the lobby and Virginia Room of the Hotel John Marshall. The U. S. Air Force will offer the second showing of its communications exhibit, which will come directly from the Grand Central Palace in New York City. The Oak Ridge Institute for Nuclear Studies will have an exhibit on radioactive substances. A number of exhibits also will be shown by individual high school students and by science clubs. Sound motion pictures having to do with the history of Virginia and various scientific subjects will be presented at several of the exhibit booths.

Tours of industrial plants and points of historical interest will be conducted on Friday afternoon. At 4:00 o'clock, the annual tea of the Academy will be held at the Valentine Museum. The Governor of Virginia will be present to welcome the scientists of the state. The Academy dinner will be served at 7:00 P.M. in the roof garden of the John Marshall. The highlights of this dinner meeting will be the presentation of the J. Shelton Horsley Research Award to a Virginia scientist for a highly meritorious paper reporting original scientific research, and an address by Howard A. Meyerhoff, administrative secretary of the American Association for the Advancement of Science. Officers of the Academy for 1949–1950 will be installed by Sidney S. Negus, Academy president.

Meetings of Sections will continue until noon on Saturday. Field trips will be conducted by geologists and botanists in the afternoon. On Saturday evening, all in attendance at the meeting are invited by those in charge of the Virginia Industrial Exposition to be guests at a preview at the Atlantic Rural Exposition grounds, arranged for members of the Academy.

The National Registry of Rare Chemicals, 35 West 33rd Street, Chicago 16, Illinois, has submitted the following list of wanted chemicals: cumic acid, 5-pentadecylresorcinol, perylene, propadiene, 1,3,5-hexatriene, myosmine, thymotic acid, thujyl alcohol, 1,2-hexadiene, 3-semicarbazidobenzamide, 2,5-thiophanedicarboxylic acid, sodium chlorosmate, sinigrin, hemopyrrole, fumigatin, 2,3-dihydroxynaphthalene, cis-9-dodecenoic acid, 2,4,5-trinitrotoluene, pyrographitic acid, and phthionic acid.

The Scientific Monthly, in cooperation with the Smithsonian Institution, will sponsor for the third year the **International Photography-in-Science Salon**, a competition to encourage and extend the use of photography as a basic research tool. Entries will be received by the editor of *The Scientific Monthly*, 1515 Massachusetts Ave., N.W., Washington 5, D. C., from August 24 to September 14, 1949.

First, second, and third awards and five honorable mentions will be given for the scientific photographs judged to be the best in the black-and-white and color sections of the Salon. Specialists in science and photography who will serve as the judging committee will consider the initiative, originality, and results obtained more than the composition and pictorial quality. All photographs must be taken for scientific purposes.

The prints selected for awards and display will be shown at the U. S. National Museum during October 1949 and at the New York meeting of the AAAS in December. They will then go on tour of scientific centers here and abroad.

Earlier prize winners have been William F. Meggers, chief of the Spectroscopy Section, National Bureau of Standards, for "Natural and Artificial Mercury, 5461 A"; Thomas C. Poulter and Walter K. Lawton, of the Southwest Research Institute, for "Photographic Study of the Explosive Charge used in the Poulter Method of Seismic Exploration"; and Edwin R. Willis, of the Philadelphia Quartermaster Depot, for a photograph taken in an investigation of the olfactory responses of female mosquitos.

The origin of corn, which has puzzled botanists for four centuries, is a step nearer solution because of a discovery in central New Mexico of cobs and pieces of corn more than 4,000 years old. The discovery was made last summer by Herbert Dick and C. Earle Smith, on a Peabody Museum expedition searching for traces of early American man in the Upper Gila River area. Over 700 cobs were found in a layer of accumulated refuse in Bat Cave, in New Mexico. By carefully removing the debris, which consisted of ashes, animal bones, and other refuse in six strata, each about a foot thick, it was possible to study the specimens. Writing in *The Journal of Heredity*, Paul C. Mangelsdorf, director of the Botanical Museum at Harvard, and Mr. Smith report that "the primitive corn found by the expedition, although probably not itself wild corn, is [possibly] not far removed in its characteristics from the long sought for wild corn." The discovery also shows that primitive corn was both a pop and a pod corn, and was not, as many botanists have supposed, derived from teosinte, a Central and South American grass closely related to corn.

Growth and Morphogenesis

Edmund W. Sinnott, *Yale University*

AN INDICATION of the great and continuing interest in the problems of organic development is the appearance of two volumes[1] of papers in this field. Those in the first volume were presented at a symposium of the Society for Experimental Biology held at Cambridge, England in July, 1947, and are now published under the title *Growth in relation to differentiation and morphogenesis.* Those in the second are an outgrowth of a conference on "The Chemistry and Physiology of Growth" held at Princeton in September, 1946, as part of the celebration of the Bicentennial of Princeton University.

These essays cover many of the fields of research in plant and animal development. They illustrate how the various disciplines of the life sciences are coming to focus on the central problem of the methods by which living matter produces those specifically formed and functioning structures which are so well termed organisms. Embryology, moving from its descriptive and phylogenetic beginnings to experimental attack, long ago began to study this question. Morphology, realizing that organic form is the visible expression of organization, began to seek the causes of form. Genetics, having outgrown its "classical" phase, is now engaged in the far more difficult problems of the mechanism of gene action and the relations between genes and the individuals which develop under their control. Physiology itself is concerned more and more with developmental problems. Various aspects of these fields are treated in the present volumes.

In the Cambridge symposium, the first paper, "The Role of the Cell in Determination" as illustrated by the metamorphosis of a blood-sucking bug, *Rhodnius*, is discussed by V. B. Wigglesworth, who suggests that "the supracellular fabric is a chemical continuum, a 'molecule' in the sense that it is held together by chemical bonds; and that it is the continuity of this substance from cell to cell which provides for the unity of the organism." It should be noted in passing that G. A. Baitsell presented this viewpoint in 1938 (*Amer. Nat.* 1940, **74**, 5–24).

The next three papers are in the familiar tradition of experimental embryology and morphology. "Concepts on the Mechanism of Embryonic Induction and their Relation to Parthenogenesis and Malignancy," by J. Holtfreter, treats of embryonic induction in amphibia. The author believes that "the external stimuli capable of inducing these phenomena are unspecific and are related to each other merely by the faculty of causing the liberation and mutation of certain morphogenetic compounds (plasmagenes) which are self-reproductive." "On the Developmental Physiology of the Sea Urchin," by S. Hörstadius and T. Gustafson, discusses certain aspects of embryonic metabolism. In "Growth and Differentiation of Nerve Fibres" J. Z. Young describes the various processes concerned in the regeneration of nerves. Although we are beginning to gain some exact information about this process, the author thinks it unlikely that our knowledge of it will be quickly reduced to simple general terms.

These are followed by three papers in a related group dealing with factors concerned in the induction of flowering in the higher plants, especially photoperiodism, vernalization, temperature, and hormones. F. G. Gregory discusses "The Control of Flowering in Plants," presenting an excellent review of the various hypotheses which have been put forward; K. C. Hamner, "Factors Governing the Induction and Development of Reproductive Structures in Plants," with especial reference to "phasic development"; and R. Harder, "Vegetative and Reproductive Development of *Kalanchoë Blossfeldiana* as Influenced by Photoperiodism." With these should also be mentioned a paper which comes somewhat later in the volume, "Morphogenic Factors as Exemplified by the Onion Plant," by O. V. S. Heath and M. Holdsworth, which postulates two hormone systems controlling the formation of bulbs and of flowers.

P. J. Gaillard describes the culture *in vitro* of endocrine glands of man, especially the parathyroid, and their transplantation into patients suffering from glandular deficiency, with resulting success in effecting cures.

Five papers are concerned with one phase or another of the problem of gene action. C. H. Waddington in "The Genetic Control of Development" discusses various ways in which specific cytoplasmic proteins, essential for the origin of differentiation, may be produced. In "Nucleus and Cytoplasm in Differentiation" K. Mather treats of the same problem from a somewhat different viewpoint. S. Spiegelman, in "Differentiation as the Controlled Production of Unique Enzymatic Patterns," supports the plasmagene theory on evidence derived from a study of enzymatic adaptation and enzyme patterns in general. Hans Grüneberg in "Genes and Pathological Development in Mammals" considers a wide range of gene effects which result in pathological or atypical characters. Ernst Hadorn describes "Gene Action in Growth and Differentiation of Lethal Mutants of Drosophila."

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[1] *Growth in relation to differentiation and morphogenesis.* (Symposia of the Society for Experimental Biology, No. II.) New York: Academic Press, 1948. Pp. vi + 365. (Illustrated.) $7.50.

The chemistry and physiology of growth. Arthur K. Parpart. (Ed.) Princeton, N. J.: Princeton Univ. Press, 1949. Pp. vii + 298. (Illustrated.) $4.50.

Plants with roots growing from their tips as an illustration of the use of plant hormones in modifying growth and development. Early work was done by P. W. Zimmerman and A. E. Hitchcock of the Boyce Thompson Institute for Plant Research, Inc., Yonkers, New York. (*Science Service Photo.*)

In quite a different vein are four papers which are concerned primarily with the development and the arrangement of leaves on the plant axis. F. J. Richards in "The Geometry of Phyllotaxis and its Origin," reviews the complex phenomena of phyllotaxis and considers various explanations which have been proposed for it. Mary Snow and R. Snow, writing "On the Determination of Leaves," consider the same problem on the basis of their experimental studies. Evidence from extensive experiments on the shoot tip is presented by Ernest Ball in "Differentiation in the Primary Shoots of *Lupinus albus* L. and *Tropaeolum majus* L.," especially with reference to histological differentiation. C. W. Wardlaw in "Experimental Morphology with Special Reference to Pteriodophytes" shows that in these plants, where the terminal meristem is dominated by an apical cell, the resulting growth pattern is essentially like that of the seed plants, where the meristem is very differently organized.

The final essay, "Observations on the Present State of Embryology," by J. H. Woodger, is a plea for more attention to the construction of hypotheses in embryology, using the logical techniques now available. These hypotheses, which he thinks will probably seem very unorthodox, should be based not only upon biochemistry and X-ray crystallography, but upon the data of embryology itself, with the emphasis upon relational properties.

The Princeton volume contains ten essays, of which the first six are primarily concerned with growth rather than development. J. H. Northrop presents a general discussion of "Enzymes and the Synthesis of Proteins," with an extensive bibliography. F. O. Schmitt, in "Molecular Morphology and Growth," describes our knowledge of the fibrous proteins, and offers some suggestions for fruitful fields of study in connection with protein molecules generally. K. V. Thimann, in "Plant Growth Hormones," reviews the multiple effects of auxin on growth, especially with isolated plant parts. K. Folkers, in "Unidentified Vitamins and Growth Factors," describes a considerable series of these and their properties. C. B. van Niel, in "The Kinetics of Growth of Microorganisms," points out that with modern techniques for turbidity measurement growth studies on populations of such organisms can be readily made, and the kinetic aspects of growth analyzed. E. S. G. Barron, in "Cellular Metabolism and Growth," shows the relation between metabolic processes and the growth and division of cells.

The last four pages are of more particular interest to students of development and morphogenesis. Paul Weiss here treats at some length the problem of "Differential Growth." He discusses cellular differentiation primarily in molecular terms, emphasizing molecular "ecology" and the importance of organization at cell surfaces. Growth, and especially its orientation and the elaboration of growth patterns, must be referred, he believes, to cellular differentiation, although behind it all, and not reducible to molecular terms, there is still a prior topographical organization to be reckoned with. There is no single master clue, he believes, to differential growth or to growth in general.

J. S. Nicholas discusses various "Problems of Organization," including nucleo-cytoplasmic relations, egg constituents, organizational dependencies, independent movements, mass movements, chemical organization, and regeneration, as illustrated in the embryology of amphibia, Drosophila, and the chick.

C. P. Rhoads approaches the problem of development through a study of "Neoplastic Abnormal Growth." He stresses especially the importance of genetic changes in the production of cancer, although self-perpetuating cytoplasmic factors and virus bodies cannot be neglected. "The neoplastic process," he believes, "is a distinctive, characteristic sort of abnormal growth, malignant as well as autonomous, something more than a quantitative deviation from the normal rate and extent of differentiation."

In "The Adrenal Gland, a Regulatory Factor," C. N. H. Long discusses the regulatory interplay of three elements of the endocrine system—anterior pituitary, adrenal cortex and medulla—and pays particular attention to the role of adrenal cortical hormones in hastening the translocation of intact cellular protein molecules to all parts of the body.

The variety of topics discussed in these volumes testifies to the wide diversity of viewpoints from which the problems of morphogenesis are being attacked and raises the question as to whether this field of biology does indeed have a content of subject matter and a program of specific objectives sufficiently different from other fields so that one is justified in treating it as a distinct discipline. Is it simply one kind of morphology, or physiology, or genetics, or is it different enough from all the rest to stand on its own feet?

The answer to our question, I think, is given in the very name morphogenesis itself—*the origin of form.* Perhaps the most distinctive aspect of living things is that they possess specific forms, those constant patterns of external and internal structure by which they can be recognized. What makes this fact significant is that form is the outward and visible expression of biological organization. Needham has well said that "the problem of organization is the central problem of biology, and the riddle of form is the fundamental riddle." Morphology deals with form, but in a descriptive and comparative manner only. So do its related disciplines of histology and anatomy. Embryology is concerned with the development of form but not its cause. Unlike these, morphogenesis endeavors to understand the mechanisms involved in form development and the fundamental causes which are responsible for it, thus striking at the heart of the problem of organization itself. Other biological sciences deal with other aspects of organisms—with their metabolism, their heredity, their evolution, their environmental relations or their classification—but only morphogenesis is concerned specifically with the problem of their organization, of what really makes them *organisms.* Morphogenesis as distinguished by its objectives thus occupies a unique position, and in a sense the topmost one, in the hierarchy of biology and seems clearly to deserve recognition as a distinct discipline.

If this is true, why should morphogenesis in practice often seem so diffuse, so fumbling? The answer is not difficult. It has, to be sure, a definite and unique goal, but this goal is one of extraordinary difficulty, since in a real sense it is the problem of life itself. It involves not only techniques of analysis, in which science is so completely at home, but the much more difficult ones of synthesis. It is concerned not only with specific substances, but more particularly with specific *relations.* The problem of organization, as the history of biology shows, is extraordinarily resistant to central attack. We can make forays into one corner of it or another, but to strike successfully at the citadel itself is so difficult that it may require tools and techniques which as yet we do not possess. It is no wonder that the morphogeneticist, circling around the periphery of his great objective, is often at a loss how to make a direct approach to it, and that his efforts frequently seem halting and ineffectual. What distinguishes a biologist when he is working in this field is not his methods, but the character of his objective.

What can the morphogeneticist do toward the solution of his problem? The volumes here under review show some of the lines of attack open to him. Much of a purely descriptive character, like Dr. Richards' analysis of phyllotaxy, yet remains to be done. In the minds of many, unfortunately, such work often suffers from the fact that it does not deal directly with causes, that it is not primarily experimental, that its conclusions do not seem to strike at the root of the matter. And yet such work is absolutely necessary to an understanding of the problems that are to be attacked, and often provides important clues for further progress. Certainly the concept of allometry, which has made it possible to express by single constants the relative growth of parts or dimensions, has simplified many of the complex phenomena of development and has made it possible to present to the physiologist a much more concrete problem than would have been possible before the use of this new technique. D'Arcy Thompson's demonstration that one organic form may be transformed into another by the regular deformation of a coordinate system in which it has been inscribed, and that any modification of this form affects the whole system rather than a local part of it, is surely not without significance for an understanding of the integrating factors in development. The student of morphogenesis in his haste to use the methods of his colleagues in physiology and biochemistry should not neglect this descriptive part of his problem, for it may well point the direction in which he must guide his steps.

Of course the morphogeneticist also employs the techniques and draws upon the data of other fields of biology, as well as of biochemistry and biophysics, and most of the progress which he has made has come in this way. An analysis of the amphibian organizer is clearly one important line of attack. So is the study of how photoperiodism, temperature, mechanical factors, and phytohormones affect the development of plant structures. No analysis of development can be complete unless it considers the role of enzymes, nucleoproteins, and other factors which are primarily biochemical in their nature. Molecular morphology and ecology must be considered. The fine structure of protoplasm cannot be neglected, nor the evidence now available from electron microscopy. Certainly without an understanding of gene action no sound theory of morphogenesis can be built. These methods of attack and many others are open to the morphogenetic practitioner and it is here that most of his efforts at present are being exerted. Their wide diversity is what sometimes lays him open to criticism as a man who cannot make up his mind as to where he is going. He knows where he would like to go, but it is extraordinarily difficult to discover the way thither.

Temptations often beset anyone who undertakes to work in morphogenesis, temptations to oversimplify his problems, to regard as a solution something that is only a first step toward it. He is inclined, for example, to look for "formative substances" which by themselves control the development of specific structures. Many specific substances are certainly important in developmental processes and their study has done much to increase our knowledge of the mechanism of growth control. But it is naive, I think, to believe that any substance, however potent, can *of itself* determine a particular organic form. We should remember the words of J. S. Haldane, that "we are faced with the question how this particular substance is present at the right time and place, and reacts to the right amount to fulfil its normal functions." The substance is merely the agent of something more fundamental, of that "prior topographic organization" of which Dr. Weiss speaks. In the same vein, Dr. Woodger in his essay calls attention to the fact that many biochemical reactions take place quite differently inside a living organism from what they do *in vitro*. We should recognize that such substances do their work not directly, but by their effects on a system of organized relations through which the ultimate control is exercised. To stop anywhere short of an understanding of such a system is to fail in the ultimate aim of morphogenesis, however valuable and necessary any preliminary steps may be.

Of course to gain such understanding is remarkably difficult. Relations seem to be much harder things to study than atoms, but we should not hesitate to explore the problem as well as we can. The idea that Dr. Wigglesworth proposes, for example, that the whole organism is a chemical continuum and thus comparable, perhaps, to a single molecule, is such an exploratory attempt, and poses a problem which can be attacked. The possible relation between the form of protein molecules and that of the organism in which they occur may well be a fruitful idea. The whole concept of morphogenetic "fields," vague as it is, is a step in the same direction. The problem we are here facing is one of the ultimates. It may well require for its solution something more than the well-established concepts with which biology has chiefly dealt. Here is the place for those new, adventurous, and unorthodox hypotheses for which Dr. Woodger pleads, hypotheses which are not vague and hazy but which can be tested by techniques now available to biologists.

The present volumes are a challenge to all students of development, for they not only present the results of some very significant work in this field, but raise again the question of what morphogenesis is and ought to be, and point to the great enigma with which every student of biology is ultimately faced and which it is useless to evade or minimize—the problem of biological organization, which is really the problem of life itself.

A Cultural Approach to World Order

Kirtley F. Mather, *Harvard University*

ALTHOUGH "WORLD ORDER" necessarily involves "world government," it is increasingly apparent that the spirit of world community is even more essential to its attainment than any blueprint of legal structure or any document embodying a world constitution. Every intelligent person is now aware of the unity of the world from a functional and geographic viewpoint. Economic isolation is a thing of the past. But from the human viewpoint ours is a world of fragments. The segments of mankind are separated by cultural and ideological chasms that are wide and deep. There can be no "world order" until men emerge from their ethnocentric bomb shelters and participate in a common cultural development toward one world of humanity.

Dr. Northrop's symposium, *Ideological differences and world order*,[1] cuts therefore to the very heart of our present, most imperative problem. Its subtitle, *Studies in the philosophy and science of the world's cultures*, sounds erudite and academic, but it is in fact one of the most practical and pertinent approaches toward meeting the world's most poignant needs that anyone could undertake. It is still true, as Thomas Huxley said long ago, that "the world in which we live is governed by ideas." To become well acquainted with the ideas that rule the lives of men—ourselves and our fellows beyond the boundary lines on maps—is the first step toward the establishment of order in our world, and indeed there is no other step that can start us along that much desired pathway.

This book is uniquely valuable not only because of its purpose but also because of the method selected to accomplish that purpose. It is concerned essentially with "the ideological differences which present obstacles on the way" to the goal of world order and with "the methods suggested by the contemporary social sciences and the philosophy of culture for the removal of these obstacles." Its authors are many rather than one. Each of them "is indigenous to or expertly acquainted with the culture upon which he writes." The 21 essays comprising the volume are superficially independent of each other and quite individualistic in style and content. But they are integrated by the common objective and together they present a gratifyingly broad and fundamentally profound analysis of the world picture. It is not an altogether happy picture, but it depicts a reality that must be accepted and that has encouraging aspects as well as discouraging ones.

First in the sequence is Dean Roscoe Pound's contribution to the symposium on "The University and Its World Responsibilities" that was part of the Princeton University Bicentennial Celebration in 1947. Published here for the first time, it stresses the idea that "men with very different conceptions of the social order, groups of men with one ideal or picture of what ought to be and other groups with wholly divergent pictures, must live together and work together in a complex social organization." Without pretending "that education . . . is the one thing needful toward a world moral and legal order," he outlines convincingly the steps that universities might take to lay a foundation for a "new *jus gentium*."

The philosophy at the basis of traditional Chinese society is expertly presented by Professor Fung Yu-Lan, of Tsing Hua University, and the philosophical basis of Chinese painting is set forth in an unusually interesting and informative essay by Chiang Yee, artist and poet now residing in Oxford, England, who formerly was an administrative official in China and who for a time was a member of the faculty of the University of London.

Professor Emeritus Charles M. Bakewell, of Yale, former State Senator and U. S. Congressman, contributes the fourth essay, an analysis of the philosophical roots of western culture, and Matila Ghyka, formerly in the diplomatic service of Rumania and now visiting professor of esthetics in the University of Virginia, discusses the Pythagorean and Platonic scientific criterion of the beautiful in classical western art. Neither of these papers is as remote and academic as its title might suggest; even a geologist gained much significant information from them.

Continuing this routine of focusing the spotlight temporarily and sequentially upon various portions of the total scene, Professor Robert Grinnell, of the University of California, writes about Franciscan philosophy and Gothic art, and Dr. Overton H. Taylor, of Harvard, presents a penetrating study of the philosophies and economic theories in modern occidental culture. Professor Leopoldo Zea, of the National University of Mexico, follows with an analysis of positivism and Porfirism in Latin America.

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[1] *Ideological differences and world order: studies in the philosophy and science of the world's culture.* F. S. C. Northrop. (Ed.) New Haven, Conn.: Yale Univ. Press. 1949. Pp. xi + 486. $4.50.

It is frequently stated that Soviet law has introduced conceptions which create an impediment to relations between the Anglo-American world and the USSR. Soviet jurists are equally sharp in their denunciations of the concepts of the common law of England and the United States. Professor John N. Hazard, of Columbia, therefore explores the charges and counter-charges and searches for the basic assumptions on which they appear to rest. Presumably with no ulterior motive for such juxtaposition, the next essay discusses the New Deal as a cultural phenomenon. It is by Professor T. V. Smith, now at Syracuse University, who concludes that "from defects as from virtues, one must nevertheless interpret the New Deal's course as America's penchant for the middle of the road."

Turning from regional to universal matters for a few moments, the book continues with an incisive, penetrating and illuminating essay by Professor P. W. Bridgman, of Harvard, Nobel Laureate in Physics, who explores the nature and the possibilities of the potential intelligent society of the future. "Never in human history has intelligence been allowed full opportunity, nor have its potentialities for a revolutionary recasting of society and culture been adequately appreciated." With his characteristically conservative optimism, Professor Bridgman believes that techniques are now in hand for making the necessary adjustments between the other emotional needs and the quest for truth, to which the first and foremost consideration must be given.

Next comes a most informative account of the philosophy of the British Labor Government by Lord Lindsay of Birker, Master of Balliol College at Oxford. In England as in America, the great unsolved problem "is whether planning is compatible with democratic freedom." The British Labor party does not yet know whether unemployment can be prevented and a high standard of living can be maintained without "a degree of compulsion entirely incompatible with [its] ideals and traditions." Across the channel the French are confronted by similar dilemmas. Professor Henri Peyre, of Yale, approaches them from the viewpoint of literature and philosophy in contemporary France.

American scientists will be especially interested in the next essay, dealing as it does with the impact of politics on science. Professor Manuel Sandoval Vallarta, of the National University of Mexico, was for a time the chairman of the United Nations Atomic Energy Commission, and in this essay he presents a cogent analysis of the conflict between ideas of security and secrecy that are natural components of the political and military mentality on the one hand and the necessity for freedom in research and communication that is recognized with equal naturalness in scientific circles on the other hand. His citation of the successful operation of the Mexican "Comisión Impulsora y Coordinadora de la Investigación Científica" since its establishment in 1943 is especially pertinent at this time when the 81st Congress is considering a National Science Foundation for the United States.

Scientists also will read with profit Julian Huxley's article about the purpose and philosophy of Unesco. It is a considerably abbreviated and slightly amended version of a pamphlet published in 1946. Since then he has become convinced that "Unesco can best achieve its aims by undertaking a program of concrete and limited projects, and that on such a program a remarkable degree of agreement can be reached among delegates with astonishingly different philosophical, racial, and cultural backgrounds." Even so, "Unesco needs not only a set of general aims and objects for itself but also a working philosophy, a working hypothesis concerning human existence and its aims and objects, which will dictate, or at least indicate, a definite line of approach to its problems."

David Bidney, Research Associate of the Viking Fund, the foundation that sponsored the entire volume, comes next with a stimulating study of the concept of meta-anthropology and its significance for contemporary anthropological science. "A genuinely scientific and realistic view of cultural dynamics will be one which is based on a healthy respect for the complexity of cultural life and for the reciprocal influence of subjective and objective factors. Only by keeping in mind the Platonic vision that integration, whether of culture or society, is essentially a matter of harmonizing the one and the many can this objective be attained." As if to prove that this is possible, the following essay by Professor Clyde Kluckholn, of Harvard, on the philosophy of the Navaho Indians, describes "not only Navaho ethics and values but also some of those highest common factors that are implicit in a variety of the doings and sayings of the Navaho."

Continuing in this same vein, Professor Francisco Romero, of El Colegio Libre de Estudios Superiores de Buenos Aires, discusses "Man and Culture," and Professor Northrop contributes a characteristically lucid analysis of ideological man in his relation to scientifically known natural man. Then, Professor Pitirim A. Sorokin, of Harvard, takes issue with Danilevsky, Spengler, and Toynbee in a short essay concerning the lasting and dying factors in the world's cultures. Finally, Gray L. Dorsey, Fellow of the American Council of Learned Societies, describes two objective bases for a world-wide legal order. These are "found in the traditional cultures of what Maine considered the two significant types of societies. This means that the fundamental bases for a universal law are present in deep-lying, lasting cultural traditions of the world."

It is Dorsey, too, in almost his last sentence, who brings us round the full circle to the thoughts with which this review began, when he writes: "The legal order must be supported in the hearts, minds, and actions of men to be vital." There of course is the crux of the whole problem. There also is the opportunity for men who have confidence in the processes of education and persuasion. And for them this book will prove both an inspiration and a treasure house of ideas and information. All such will agree that Professor Northrop's endeavor and the labors of his galaxy of writers have not been in vain.

Cybernetics: A New Discipline

Churchill Eisenhart, *National Bureau of Standards, Washington, D. C.*

HAVE YOU TAUGHT SOMEONE to drive a car lately? If not, perhaps you can recall how when you yourself were learning to drive, the car, in response to your instructions, veered first too much to the left, then too far to the right, and generally pursued an awkward zigzag course down the road. With training you or your protegé no doubt learned to pilot a car so that it proceeded smoothly, without jerks or wobbles, from one to the other of two given points by what you believed to be the shortest route consistent with the rules of the road and the curves involved. If these remarks bring to mind vivid recollections of the kind of experience just described, then you have already had good firsthand experience with applied cybernetics, and (whether you realize it or not) you already know something about the subject.

The word *cybernetics* is a neo-Greek expression coined to fill a need felt by Professor Wiener[1] and his associates for a single term, unprejudiced by previous usage, that could be used to designate the whole expanse of control and communication theory pertinent to the description, analysis, or construction of systems that involve (1) mechanisms (receptors) for the *reception* of *messages* or stimuli, (2) means (circuits) for *communication* of these to (3) a central *control unit* that responds by *feeding back* through the system (4) *instructions* that (will or tend to) produce *specific actions* on the part of (5) *particular elements* (effectors) of the system. To this end, the word *cybernetics* was therefore formed from the Greek word for *steersman*, χυβερνήτηξ (kybernetes). Besides having approximately the desired connotation, this Greek word is all the more symbolic on account of the fact that its Latin corruption, *gubernator*, is the origin of our word *governor*, and, Professor Wiener points out, the first significant paper on feedback mechanisms is the article published by Clerk Maxwell in 1868 on the theory of the purely mechanical feedback system represented by the governor of a steam engine, a device invented by James Watt to regulate the velocity of his steam engine under varying conditions of load.

The central concept in cybernetics is a feedback mechanism that, in response to information (stimuli, messages) received through the system, feeds back to the system instructions that modify or otherwise alter the performance of the system. It is important in cybernetics to distinguish *positive feedback*, which serves to increase what the system is doing in magnitude or direction, from *negative feedback*, which serves to oppose the performance of the system, e.g., to reduce its magnitude or change its direction. Thus, in psychology and neurophysiology one distinguishes between situations wherein an organism responds to a stimulus in such a manner as to acquire an increased amount of the stimulus (*adience*), and situations wherein the response is such as to reduce the amount of the stimulus received (*avoidance*). In practical affairs, positive feedback is generally scrupulously avoided, since, if uninhibited, it will lead obviously to an extreme state. Two cases of positive feedback in moderation that come to the reviewer's mind are (a) adience of young mammals, which is essential to proper receipt of nourishment and to keeping warm; and (b) the regenerative circuits used in radio receivers in the early days, to regenerate and thereby intensify a weak signal. Negative feedback mechanisms, on the other hand, are used widely, and are of considerable interest, for they embody what is generally implied by the word "control."

As we have noted, the governor of a steam engine is an example of a purely mechanical (negative) feedback mechanism. In the original form designed by Watt, two balls attached to pendulum rods swing on opposite sides of a rotating shaft, and their position, via a mechanical linkage attached to a collar about the shaft, controls the opening of the steam valve, reducing the opening when the balls rise (increasing speed), and widening the opening when the balls fall (decreasing speed). Since the balls are thrown outward and upward by centrifugal force (the magnitude of which depends directly upon the angular velocity of the shaft and ultimately upon the amount of steam admitted through the valve) and are pulled down by their own weight, the system seeks a compromise state which with good design is achieved promptly and is preserved. In consequence the engine operates uniformly at the prescribed speed unless the load is changed, calling for more or less steam, which adjustment the balls promptly achieve. Bad design of the governing mechanism, on the other hand, may send the valve into violent oscillation and cause the engine to behave much like an automobile in the hands of a beginner who treads too heavily upon the gas, causing the car to lurch ahead, so that he releases the pressure of his foot upon the throttle, whereupon the car slows up abruptly and he increases pressure upon the throttle and produces another lurch ahead, and so forth.

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[1] *Cybernetics: or control and communication in the animal and the machine.* Norbert Wiener. New York: John Wiley; Paris, France: Hermann et Cie, 1948. Pp. 194. $3.00.

The ordinary thermostat by which the heating of a house or a room is regulated is perhaps a more familiar example of a negative feedback system. More commonplace, but probably least familiar of all, is the nervous system, which contains a control mechanism that makes possible the performance of our voluntary actions. With training and experience a child can pick up a pencil, cigarette, or piece of candy, without awkward gropings; but if the control mechanism in the cerebellum is in poor adjustment, as in the infant, considerable "hunting" takes place before the hand finds the object; and if the mechanism is damaged by injury to the cerebellum, attempts to pick up an object may (probably will) send the arm into violent oscillations of *cerebellar* or *purpose tremor*.

Although *feedback* (and the *control* over a mechanism thereby effected) constitutes the central theme of cybernetics, there can be no feedback and no control unless there is communication of the incoming message (stimulus) from the receptor to the feedback mechanism and transmission of its message (instructions) to the effector parts of the system (e.g. to the valves of a machine, or to the muscles of an animal). The theory and techniques of *communication* are, therefore, fundamental parts of cybernetics. Since communication of a message may be represented quite generally as a times series of impulses, this brings in the study of *time series,* and especially the statistics of time series, in view of the problem of separating the message carried by a series of impulses from the random "noise" mixed in with the basic signal. Consequently, the theory of wave filters and other devices used in telephone, radio, and television circuits for unscrambling messages from mixed series falls within the province of cybernetics, as does also the theory of fire control devices for directing gunfire. These latter must resolve the true course of a target from the mixed and often contradictory impressions received (as a result of observational errors arising from turbulence of the atmosphere, if the sighting is optical; from static, if radar is used) and compute a predicted position at which to direct the shell. Consideration of such automatic fire control equipment for directing gunfire leads naturally to consideration of automatic sequence-controlled electronic and mechanical computing machines. The analogies of such systems to the brain and the nervous system are tempting.

In *Cybernetics*, the first volume of a projected series, the author has undertaken to survey the entire field of control and communication theory and its various ramifications. He has been remarkably successful in pointing out the similarities and equivalences (from a mathematical viewpoint) of many diverse phenomena of man, animal, machine, and society; and has thus achieved a certain unified approach to problems "of vital importance to psychologists, physiologists, electrical engineers, radio engineers, sociologists, philosophers, mathematicians, anthropologists, psychiatrists, and physicists." To this impressive list might be added also astronomers, geologists, meteorologists, geneticists, and others. Later volumes are to cover specific applications in detail. (A second volume, ***Extrapolation, interpolation and smoothing of stationary time series, with engineering applications,*** by the same author, is scheduled for publication in June 1949.) The present volume exhibits the value of cybernetics as an analogical tool; its sequels are to demonstrate the power of the method in particular contexts.

In approaching the present volume, the reader should not be discouraged by the mathematical discussions, and should attend more to the spirit of the mathematics than to its detail. Fortunately, the essential ideas are amply expounded in the verbal text; so that on first reading, at least, one can profitably read along at a good pace, omitting the more troublesome mathematical portions. The tremendous scope of this book is evidenced by its chapter headings: (I) Newtonian and Bergsonian Time; (II) Groups and Statistical Mechanics; (III) Time Series, Information, and Communication; (IV) Feedback and Oscillation; (V) Computing Machines and the Nervous

System; (VI) Gestalt and Universals; (VII) Cybernetics and Psychopathology; (VIII) Information, Language, and Society. A panoramic view of the whole is given in the 33-page introduction, which ends with a pessimistic view of the future of human society and a note of discouragement concerning the possibility of developing an exact science of economics or sociology. The reader who is neither a mathematician nor an engineer may profitably skip from the introduction to Chapter IV, on first reading. Chapters II–IV are of particular interest to the mathematician and the electronic engineer; and Chapter III is of interest to the student of theoretical statistics, in view of its new approach to the notion of the amount of information in a series of data.

The text of the American edition, which appears to be a reproduction of the Paris edition (either by use of the same plates or by photographic means), unfortunately contains a fairly large number of typographical errors. The present volume is also without an index. It is to be hoped that these shortcomings will be rectified in future editions of the present volume and given due consideration in the publication of other volumes of the projected series.

Cosmic Science and the Social Order

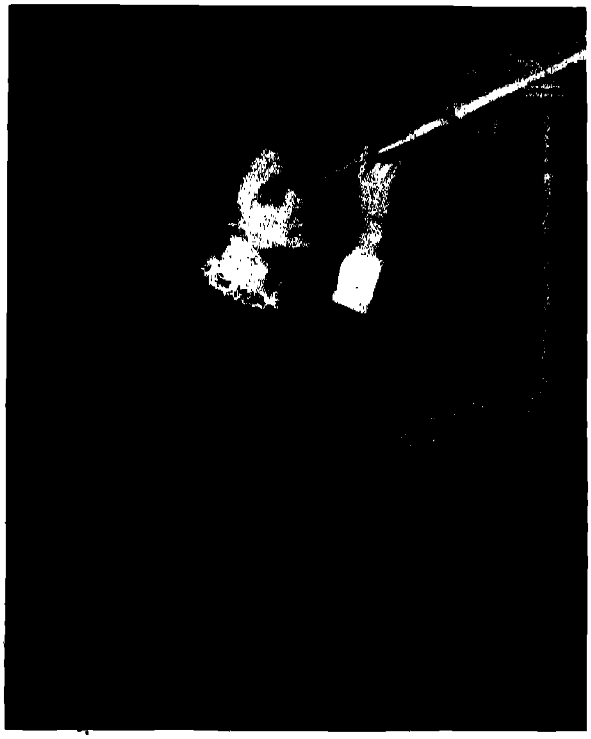
Harlow Shapley, *Harvard Observatory*

THE MARIA MITCHELL of a century ago and the Albert Einstein of the present come together naturally in a joint review because along with their concern for sanity in social affairs neither slackened in ardor for knowledge of the universe. Maria Mitchell followed well-established lines in her astronomical work, but broke new ground in advocacy of higher education for women. Einstein broke new ground in the interpretation of the universe, then joined the hard fight for the lives and rights of free men.

The books under review[1] are the story of the life and work of a New England spinster of the middle of the 19th century, and the story of a portion of the deep and revolutionary thought of a master mind of this first half of the 20th century. Both volumes are readable and thought provoking.

In her volume, *Sweeper in the sky*, Miss Helen Wright has completed a study to which she has devoted many years. Herself a former student of astronomy in Vassar College, where Maria Mitchell, 80 years ago, spent some of the most fruitful years of her life, Miss Wright explored most thoroughly the earlier career of this outstanding woman scientist—this native of historic and romantic Nantucket Island, where her banker-scientist father guided her early astronomical studies and explorations. The Nantucket of those days was something of a cultural center, visited by the famous poets, writers, and scientists, and the Mitchells did much to make the local culture.

Sweeper in the sky is a volume of charm and unusual interest, largely because it deals with significant phases of mid-19th-century America. The lives and principles of the orthodox Quakers of Nantucket, and the young girl scientist's gradual, struggling withdrawal from the credal inflexibility of that religious group, make a fascinating tale.



From being a quiet, intense observer of the stars, Maria Mitchell rose suddenly to international fame through the discovery of a comet in 1847. The comet soon disappeared, but her fame remained. She was elected in 1848 the first woman member of the American Academy of Arts and Sciences, and remained the only woman member throughout the 19th century. It was not until 1943 that the somewhat stiff gentlemen of that ancient organization, which started with George Washington and John Adams in the early membership, yielded to the ferment that had quietly been planted by Maria Mitchell and her sister intellectuals; the Academy then elected four women to membership. In 1850 Maria Mitchell was elected to the AAAS—another first.

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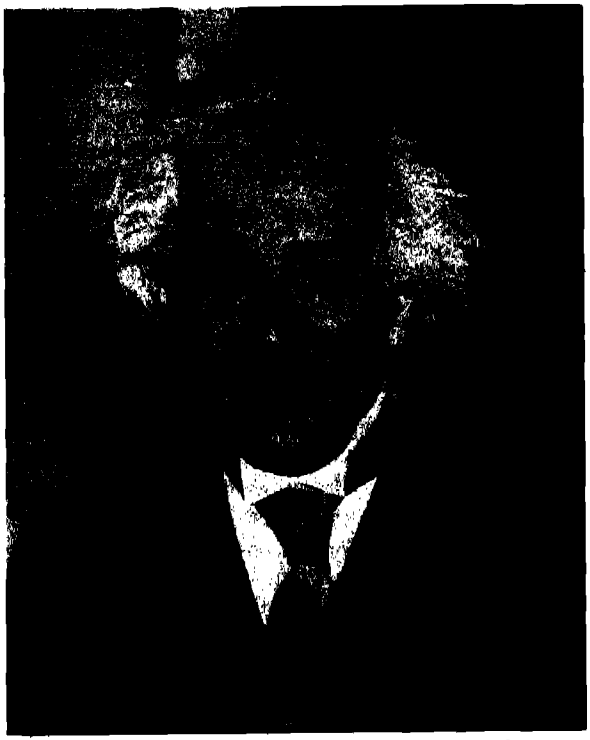
[1] *Sweeper in the sky*. Helen Wright. New York: Macmillan, 1949. Pp. vii + 254. $4.00.
The universe and Dr. Einstein. Lincoln Barnett. New York: William Sloane, 1948. Pp. 127. $2.50.

That one ordinary comet, discovered with the small telescope on Nantucket Island, brought Maria Mitchell the prestige that her spirit and abilities merited. Without the recognition and responsibility, her career might have been obscure. If she had not been the first to detect the comet, it would have been picked up by another—in fact, it was independently discovered by Father da Vico of Rome a few days later. But the astronomers and public of old, as of now, attach a rather spurious importance to the individual who anticipates his colleagues by a few hours or days in seeing (or photographing) and officially reporting a new comet. Frequently we hang his name on the comet, and nowadays give him the Donahue Comet Medal, established and operated by the Astronomical Society of the Pacific. A century ago the King of Denmark established himself as a patron of the sciences, arts, and publicity by bestowing his royal blessing, and a medal, on the first discoverer of a new telescopic comet. Maria Mitchell got that medal and many congratulations from important people of the era. She was embarrassed by the acclaim, of course, but her family, her town, and her country were proud.

Just one hundred years ago this month, the Denmark King's medal was put on display at a meeting of the American Academy of Arts and Sciences. At that same meeting there were discussions, by Benjamin Pierce and others, of the motions of the recently discovered major planet, Neptune. That was an exciting decade, astronomically—there was the monstrous comet of 1843, the discovery of Neptune, and the founding at Harvard of the first large astronomical research institution in America—probably these events helped to enhance the wide fame of the studious lady of Nantucket. Her trip abroad (she traveled at times with Nathaniel Hawthorne and family) was scientifically a triumphal tour. She was rated along with Mary Somerville, the British mathematical astronomer and science writer, as the top woman scientist of the mid-century. On her travels she carried the first photograph of a star—a latchkey provided her by the Bonds of the Harvard Observatory.

It was natural, of course, that the hard-thinking, industrious and shy Maria Mitchell was asked to join the faculty of the new Female College founded at Poughkeepsie by Matthew Vassar. All those who are interested in the early history of that pioneer educational enterprise will find *Sweeper in the sky* an instructive introduction. They will also like the tales of the Nantucketers and will chuckle over the foibles of the religious and intellectual leaders of Maria Mitchell's time and admire their virtues. The reader of Lincoln Barnett's *The universe and Dr. Einstein* will not find many chuckles in his small volume. They are, however, going to find something that to many appeals more deeply. They are going to find, for the first time in their inquisitive lives, that they really can "catch on to what this here relativity business means." Mr. Barnett, a journalist who has graduated into professional authorship, favored me with part of his manuscript, asking if I would not check up on this and that. A good many manuscripts come my way, and I confess that Mr. Barnett's pages were about to receive the kindly treatment that is customary, I am afraid, when laymen handle cosmogony, or the nature of universal forces, or the theory of relativity. But the first paragraph revealed that the author has understanding and a facility of explaining the well-nigh inexplicable. He has done the best job I have seen in presenting partially the nature of the relativistic universe, and the history of Einstein's thoughts as the still incomplete picture unfolded in his mind.

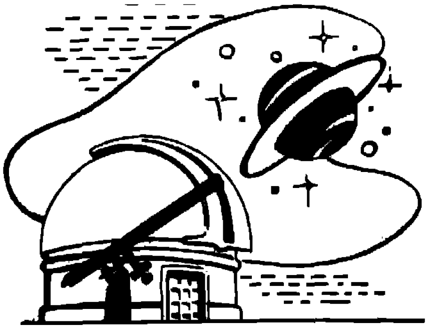


Mr. Barnett, with degrees from Princeton and Columbia, has turned directly to the masters at those institutions, to Hermann Weyl, Valentin Bargmann, H. P. Robertson, and William W. Havens, Jr. But I venture to suggest that the clarity of the presentation of Einstein's universe did not come from the masters—they know too much!

In his introduction to the volume, Einstein says that "the main ideas of the theory of relativity are extremely well presented. Moreover, the present state of our knowledge in physics is aptly characterized. The author shows how the growth of our factual knowledge, together with the striving for a unified theoretical conception comprising all empirical data, has led to the present situation which is characterized—notwithstanding all successes—by an uncertainty concerning the choice of the basic theoretical concepts." Einstein also warns against the sort of popularization that "succeeds in being intelligible by concealing the core of the problem and by offering to the reader only superficial aspects or vague allusions, thus deceiving the reader by arousing in him the deceptive illusion of comprehension."

Perhaps Mr. Barnett's readers may believe they comprehend more than is possible from a volume which must put its only mathematical symbolism in a brief appendix. But whether or not they are somewhat deceived by the clarity of the presentation, those who have never looked thoughtfully into the problems of the nature of the world in which they live are going to turn from this volume a bit startled and starry-eyed; and many will wish it were twice the length so that some of the ideas too briefly touched upon could have been spread out and illuminated. They will want to know more of the development of some of these surprising concepts—of the primordial field, the structure of space, atomic transmutation, and the fundamental mystery, still defying us, of clearly and unambiguously linking up the nature and forces of the microsomes with the nature and forces of the subatomic.

The portrait of Maria Mitchell, used as an illustration in Sweeper in the sky, *was painted by H. Dassel in 1851. Dr. Einstein's photograph is reproduced here by permission of Science Service.*



Comments and Communications

Do Fish Fall from the Sky?

In view of the prevailing skepticism about rains of fish, my own observations of this phenomenon may interest the readers of *Science*.

A rainfall of fish occurred on October 23, 1947 in Marksville, Louisiana, while I was conducting biological investigations for the Department of Wild Life and Fisheries. In the morning of that day, between seven and eight o'clock, fish ranging from two to nine inches in length fell on the streets and in yards, mystifying the citizens of that southern town. I was in the restaurant with my wife having breakfast, when the waitress informed us that fish were falling from the sky. We went immediately to collect some of the fish. The people in town were excited. The director of the Marksville Bank, J. M. Barham, said he had discovered upon arising from bed that fish had fallen by hundreds in his yard, and in the adjacent yard of Mrs. J. W. Joffrion. The cashier of the same bank, J. E. Gremillion, and two merchants, E. A. Blanchard and J. M. Brouillette, were struck by falling fish as they walked toward their places of business about 7: 45 a.m. There were spots on Main Street, in the vicinity of the bank (a half block from the restaurant) averaging one fish per square yard. Automobiles and trucks were running over them. Fish also fell on the roofs of houses.

They were freshwater fish native to local waters, and belonging to the following species: Large-mouth black bass (*Micropterus salmoides*), goggle-eye (*Chaenobryttus coronarius*), two species of sunfish (*Lepomis*), several species of minnows and hickory shad (*Pomolobus mediocris*). The latter species were the most common. I personally collected from Main Street and several yards on Monroe Street, a large jar of perfect specimens, and preserved them in Formalin, in order to distribute them among various museums. A local citizen who was struck by the fish told me that the fish were frozen; however, the specimens I collected, although cold, were not frozen. There is at least one record, in 1896 at Essen, Germany, of frozen fish falling from the sky. The largest fish in my collection was a large-mouth black bass 9¼ inches long. The largest falling fish on record was reported from India and weighed over six pounds.

The fish that fell in Marksville were absolutely fresh, and were fit for human consumption. The area in which they fell was approximately 1,000 feet long and about 75 or 80 feet wide, extending in a north-southerly direction, and was covered unevenly by fish. The actual falling of the fish occurred in somewhat short intervals, during foggy and comparatively calm weather. The velocity of the wind on the ground did not exceed eight miles per hour. The New Orleans weather bureau had no report of any large tornado, or updrift, in the vicinity of Marksville at that time. However, James Nelson Gowanloch, chief biologist for the Louisiana Department of Wild Life and Fisheries, and I had noticed the presence of numerous small tornadoes, or "devil dusters" the day before the "rain of fish" in Marksville. Fish rains have nearly always been described as being accompanied by violent thunderstorms and heavy rains. This, however, was not the case in Marksville.

Certainly occurrences of this nature are rare, and are not always reported, but nevertheless they are well known. The first mention of the phenomenon was made by Athanaseus in his *De pluvia piscium* nearly two thousand years ago, and E. W. Gudger, in his four collective articles, reports 78 cases of falling fish from the sky. There is no reason for anyone to devaluate the scientific evidence. Many people have never seen tornadoes, but they do not doubt them, and they accept the fact that wind can lift and carry heavy objects. Why can't fish be lifted with water and carried by the whirlwind?

Oyster Laboratory, Biloxi, Mississippi A. D. BAJKOV

The Linda Hall Scientific Library, Kansas City, Missouri

Readers of scientific literature are watching with great satisfaction the impressive growth of the Linda Hall Library in Kansas City. This library, by agreement, is to be devoted exclusively to books and periodicals on science and technology. It should become the mecca for all scientific readers of the western central states.

The library was created eight years ago by an endowment in the will of Herbert F. Hall, a business leader of the vicinity. An estate of sixteen acres, four miles south of the business district of Kansas City and adjoining the campus of the University of Kansas City, was provided for the purpose. The library bears the name of the wife of Herbert F. Hall (both Mr. and Mrs. Hall are now deceased). The first books and periodicals were purchased three years ago.

The library is only a few blocks away from the Nelson Art Gallery, the Art Institute, and Rockhurst College. It will be near the grounds of the Midwest Research Institute when that organization moves to its new site in Kansas City.

Five trustees, appointed by Mr. Hall, decided that the new library should cover "the field of basic science and technology" and minister freely to the needs of "science scholars and research men." The library works in close cooperation with other libraries of Kansas City, and, under the terms of the will, it serves the scientific and technical book needs of the University of Kansas City faculty and student body. The University has transferred most of its books on science to the shelves of the Linda Hall Library and all science periodicals necessary to the science departments of the University are now provided by the Linda Hall Library.

Books and periodicals are coming in so rapidly that hardly any accurate statement can be made now on what the library has to offer. A recent estimate places the number of bound volumes over 100,000. More than 2,200 current periodicals are now coming in by subscription and by gift. The collection covers such fields as those of the basic sciences and the industrial arts, and includes meteorology, building and construction, aeronautics, printing, mining and metallurgy, and radio.

The bound periodicals of many scientific academies and societies extend without interruption back to the 17th and 18th centuries. For some of the more recent sciences the sets are complete—for example, all of the United States Geological Survey publications are provided, and several sets of the State Geological Survey publications are nearly complete.

The reader may sit in a reading room of the library and have books brought to him by a library attendant from floors above and below or from the adjacent building. Or, in the periodical reading room, he may ask for any of the 2,200 files of periodicals, including the latest issues. The present full-time staff is eleven people, including four professional librarians.

John R. Ball

University of Kansas City

Atmospheric Pressure and Bird Flight

While the following observations have no direct bearing on the discussion of bird migration, they may contribute something as regards the effect of atmospheric pressure on bird flight.

In the fall of 1933 I was aboard a slow cargo ship on the great circle course, Lisbon to New York. A small West Indian hurricane had started north about the time we left Lisbon; it should have been entirely dissipated long before we "went over the hill." But the storm was also slow, and was still meandering up the coast when we reached the Newfoundland Banks. By calculation, it was due to strike inland at New York at the time we would be off Boston; our course was shifted to the eastward, to run well outside and ride in behind it.

This proved rather to be a collision course, for the storm recurved and followed the Long Island coast outward, with the result that we ran squarely into it off Nantucket, in a quadrant and at an angle which no navigator would deliberately have chosen. There was nothing then to be done but heave to and hope for the best; and, in due time, the storm center passed directly over us.

Any hurricane is a major disturbance, but fortunately this one was not of maximum area or intensity. It was, however, still intact and perfectly formed; the center, of course, was characterized by clear sky, absence of wind, and the confused seas piling one atop another from the four quadrants. The unexpected feature, however, was the fact that the center area was clearly defined by the presence of innumerable birds, land and shore birds of all sizes which had been sucked up and carried along, as helpless as if confined within a room except that the progressing storm forced them to keep in constant flight.

Starved, parched and exhausted, those that could sought refuge on the ship; rails, rigging and lifelines were covered with them; the decks were awash with drowned bundles of feathers. More than 30 kinds of birds were counted, including an owl. Many were taken inside and every effort was made to save them, but only one, a long-legged shore bird, survived.

The most pitiful case was that of a great black wild duck which tried desperately to beat its way to the ship from only a few yards off. Its "flight ceiling" was so low that its powerful wings could not raise it above the crest of the seas, which were about mast high. Three times we watched it fly straight into an oncoming sea, and emerge, still "flying" from the other side; the fourth time it did not reappear.

Whether pressure and other atmospheric factors accounted for the low flight that caused this one and so many others to drown, or whether it was weakness alone, I do not know. It was certainly the pressure system that placed them in this tragic situation. This example would seem to be the reverse of that cited by C. Suffern of England, whose redwings were carried along the *outer edge* of the pressure system, presumably on the wind. These were in the wind-free center, but were carried out to sea because they could not break through the walls of wind. It was curious that there were no sea birds among them; yet the storm, although it had hugged the coast, had not gone inland at any point. Evidently they had been picked up by the fringe winds and blown into the center, much as the seas were dragged in. Since it was entirely involuntary on the part of the birds, this mass displacement could not, of course, be considered a migration; but it might be assumed that migratory birds would attempt to avoid such pressure systems.

Dorothy Ford Mayhew

Institute of Geographical Exploration,
Harvard University

On the High Prices of Scientific Books

This is in the nature of a protest against the present high prices of scientific books. In recent years the cost of books has doubled and tripled until it is now virtually impossible for many scientific workers to own volumes they need and this is to say nothing of the poor student, who has to struggle to pay for texts that are absolutely essential.

In my opinion, a personal library, however small it might be, is an inestimable aid to a student in gaining and *retaining* a grasp of his subject. The present situation forces many to sell their current texts to pay for the ones needed in the following semester.

The prices of many articles are falling, and we can only hope that books will follow suit. As a remedial measure, might I suggest the European procedure, whereby books are issued in both unbound and bound form. This would reduce the price of many books by about 25 percent. I see no reason for paying $4.00 for a 147-page book—the price asked for a recent publication.

John R. Lowry

General Foods Corporation,
Hoboken, N. J.

Book Reviews[1]

The science of biology today. Trofim Lysenko. New York 16, N. Y.: International Pubs., 1948. Pp. 62. $1.25.

On July 31, 1948, Academician Trofim Lysenko delivered his presidential address to the V. I. Lenin Academy of Agricultural Sciences in the USSR. That address forms the substance of this small book. It must indeed be read to be believed.

The address began with a dissection of Darwinism in the light of the opinions of Marx and Engels. Soviet scientists are strong Darwinists. They acknowledge, to be sure, the existence of certain errors in Darwin's thought, traceable chiefly to the pernicious, "reactionary" influence of Malthus. In plain language, what the Soviet Darwinists reject is the Theory of the Struggle for Existence within species and of the Survival of the Fittest. What remains of Darwinism after this evisceration is the theory of the effects of use and disuse in modifying hereditary characteristics, and the elaborate and completely unsupported theory of pangenesis.

Having made Darwin equivalent to Lamarck, Lysenko passed on to demolish the ideology of his *bête noire*, August Weismann. Having done this to his satisfaction, he posed the question of the inheritance of acquired characteristics, said flatly that the Lamarckian propositions are "quite true and scientific," and interpreted them as equivalent to maintaining that the "qualitative variations of the nature of plant and animal organisms depend on the conditions of life which act upon the living body, upon the organism." Having completed this *tour de force*, it follows that "the Mendel-Morgan teaching, which is metaphysical and idealist in its essence, denies the existence of such dependence, though it can cite no evidence to prove its point." The essence of "idealistic" error is to divide "the living body into two separate substances: the mortal body (or soma) and an immortal hereditary substance, germ-plasm."

In subsequent passages the evolutionary views of the great Russian morphologist Schmalhausen were attacked and the studies of population genetics conducted by Dubinin and his associates were ridiculed as sterile and impractical. This paved the way for the apotheosis of Michurin, Lysenko's own guide and mentor, and introduced the subject of vegetative hybrids. Michurin has claimed that: "Any character may be transmitted from one strain to another by means of grafting as well as by the sexual method." One "shakes" the nature of a vegetable organism by various means, renders it plastic in heredity, and then by grafting induces a transfer of characteristics.

Having deplored the teaching of Mendelian-Morganian genetics in Soviet universities and institutes, Lysenko stated that "under the influence of Michurian criticism of Morganism young scientists with an insight into questions of philosophy have in recent years come to realize that the Morganist views are utterly alien to the world outlook of Soviet people." At least, they knew on which side their bread was buttered!

The one piece of evidence for his views actually mentioned by Lysenko in this address was the conversion of hard spring wheat (durum) into soft winter wheat (vulgare), at a single step, after two to four years of autumn planting. It is difficult to see what this genome mutation from a 28-chromosome wheat to a 42-chromosome wheat has to do with the argument for the inheritance of acquired characteristics. "Classical" geneticists are selecting adaptive mutants by means of environmental conditions in hundreds of laboratories. The real question, which is whether such mutants fail to appear or appear with a lower frequency in the absence of the said conditions, is a question which Lysenko avoided altogether.

At this point the speaker ended. A discussion ensued, and Lysenko arose to answer a specific question regarding the attitude of the Central Committee of the Communist Party toward his report. The answer: the Committee had examined his report and had approved it. In other words, Lysenko's doctrines were completely victorious. The debacle of scientific reason which followed was complete—expurgation of reactionary genetics from all textbooks, reorientation of university staffs, purging of noted geneticists and evolutionists, hurried recantations by middle-of-the-roaders before it was too late.

In his concluding remarks Lysenko outdid himself. ". . . Heredity is inherent not only in the chromosomes, but in any particle of the living body . . . for heredity is determined by the specific type of metabolism. You need but change the type of metabolism in a living body to bring about a change in heredity." Lysenko brought forward as evidence a tomato plant. It was a vegetative hybrid between a strain with entire leaves and red fruit, used as the stock, and another with pinnate leaves and yellow fruit, used as the scion. Most of the plants from the seeds produced by this graft hybrid were like the stock or scion on which they were borne. But six plants from seeds borne on the stock had pinnate leaves and yellow fruit. And this was reported to have happened again in some seeds produced by normal entire-leaved, red-fruited F_1 plants derived from the stock. This interesting report ignores all the previous work done on graft hybrids, begun by Winkler in 1907, and the discovery of chimeras so produced, in 1910. The one new claim, which should certainly be checked by workers elsewhere, is that a chimeral condition can be transmitted through the seed for several generations. But, of course, Lysenko himself does not believe in chimeras.

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[1] Complete index to all book reviews is given on pages 429–430.

The final blasts on this notable occasion were directed at the dependence of Mendelism-Morganism on chance. It is imperative to quote these statements, which illuminate the entire Soviet attitude toward science:

"All the so-called laws of Mendelism-Morganism are *based entirely on the idea of chance.*"

"'Gene' mutations . . . appear fortuitously . . . the direction of the process of mutation is also fortuitous. Proceeding from these invented fortuities, the Morganists base their experiments, too, on a fortuitous choice of substances that might act as mutation factors, believing that they are thereby acting on their postulated hereditary substance, which is just a figment of their imagination, and hoping thereby to obtain fortuitously what may by chance prove to be of use. According to Morganism, the separation of the so-called maternal and paternal chromosomes at reduction divisions is also a matter of pure chance. Fertilization . . . does not occur selectively, but by the chance meeting of germ cells. . . .

"*On the whole, living nature appears to the Morganists as a medley of fortuitous, isolated phenomena, without any necessary connections and subject to no laws.* Chance remains supreme."

"Unable to reveal the laws of living nature, the Morganists . . . reduce biological science to mere statistics. . . . Mendelism-Morganism is built entirely on chance; this 'science' therefore denies the existence of necessary relationships in living nature and condemns practical workers to fruitless waiting. There is no effectiveness in such science. With such a science it is impossible to plan, to work toward a definite goal; it rules out scientific foresight. . . . Physics and chemistry have been rid of fortuities. That is why they have become exact sciences. . . . *By ridding our science of Mendelism-Morganism-Weismannism we will expel fortuities from biological science.* We must firmly remember that *science is the enemy of chance.*"

"Long live the party of Lenin and Stalin, which discovered Michurin for the world and created all the conditions for the progress of advanced materialist biology in our country." (Italics in original.)

BENTLEY GLASS

Johns Hopkins University

The Royal Society Empire Scientific Conference, June–July 1946. (2 vols.) Edinburgh, Scotland: Morrison and Gibb Ltd., 1948. Vol. I: 828 pp.; Vol. II: 707 pp. (Illustrated.) 2: 2: 0 net.

The Empire Scientific Conference had its beginnings in discussions by representatives of the British Ministry of Supply and the British Commonwealth Scientific Office in Washington with representatives of the Royal Society. Following a conference called by officers of the Royal Society and attended by representatives of Canada, Australia, New Zealand, South Africa, and India, a British Commonwealth Science Committee was set up under the chairmanship of Sir Henry Dale and with Dr. Alexander King as Secretary. The report of this Committee, published in April 1943, proposed an Empire Scientific Conference to be convened as soon as possible after the war. In January 1945, expenses for the Conference were allocated by the Treasury in the amount of £15,000. A Policy Committee for the Conference began work early in 1945 under the chairmanship of Sir Alfred Egerton. The Conference itself took place June–July 1946, in London, Cambridge, and Oxford. There were 114 delegates representing different countries within the British Commonwealth. The larger delegations included: Australia—9, Canada—15, India—14, South Africa—7, and United Kingdom—38. The Steering Committee, composed of 12 leading scientists, included Sir Robert Robinson, president of the Royal Society, and the four other chief officers of the Society, and was under the chairmanship of Sir Henry Tizard. The Conference was organized mainly around 15 major scientific topics for each of which a steering group was appointed with a chairman, a recorder, and from six to ten other representative scientists as committeemen. The first three days were devoted to a stock-taking review of scientific organization: 1) in the United Kingdom; 2) in Canada, New Zealand, and the Colonial Empire; and 3) in Australia, South Africa, and India. Volume I, pages 43–298, presents the prepared papers, discussions, charts, and tabular matter relative to the organization of scientific research and much concerning current (1946) research.

In reviewing such a large report it is possible only to give an outline. Six of the fifteen main topics of the Conference are reported in about 500 pages of Volume I. These topics in order are: A—Outstanding Problems in Agricultural Science in the Empire; B1—Medical Science: Physiological and Psychological Factors Affecting Human Life and Work under Tropical Conditions and in Industry; B2—Etiology and Control of Infectious and Transmissible Diseases, particularly those which are insect-borne; C—Science of Nutrition, including Nutritional Status of the Indigenous Peoples of the Colonies; D—Aerial Mapping, including the Use of Radio Technique in Ordnance Survey; and E—Measures for Improving Scientific Information Services, including Indexing, Abstracting, Special Libraries, and Microfilms. Each of these sections begins with a listing of the personnel of the steering group, followed by a brief digest of the report on the subject, a general statement, and finally, the Conference recommendations in reference to research and further development.

Nine topics, to which as many full morning sessions were devoted, are reported in Volume II. Briefly listed, these topics were the following: F—Interchange of Scientists, including Discussion on the Future of the Scientific Liaison Offices That Have Been Established during the War; G—Empire Cooperation in Science with Existing and Projected International Organizations; H—Physical Standards and the Use of Units, Terms and Symbols; I—Collection and Interchange of Scientific Records and Experimental Materials, including Discussion of Risks

Involved in the Distribution of Plants, Seeds and Animals; J—Land Utilization and Conservation throughout the Empire; K—The Need for a Coordinated Survey of the Mineral Resources of the Empire; L—Natural Resources of the Empire and the Chemical Industries That Are or Might Be Based on Them; M—Post-War Needs of Fundamental Research; and N—Coordination of Scientific Work within the African Continent.

The Conference in some evening discussions gave consideration and arrived at recommendations in reference to five large topics: Cosmic Rays, Fish Culture, Geochemistry, Hormones, and Fisheries (see Volume II, pages 529–662); the full calendar of the Conference is given on pages 663–677. At the end of each volume there is a complete index for both volumes, comprising about 30 pages. The index gives names of speakers and discussants (not presiding officers and organizing and committee personnel) and of scientific topics of discussion and related entries. A long list of traveling fellowships and scholarships open to students and research workers is provided in Volume II, pages 37–82.

The topic of broadest interest was "morning subject (m)," The Needs of Research in Fundamental Science After the War. The material on this subject for discussion by the delegates consisted of a previously completed report of the Royal Society on Post-War Needs of Fundamental Research, produced by eight committees representing, respectively, Physics, Chemistry, Biology and Biochemistry, Geophysics, Geology, Geography, Meteorology, and Oceanography. The most general recommendations developed were: I) The mechanism for guiding long term research in fundamental science in each country of the Commonwealth should be carefully reviewed in order to foster fertile research work in all important subjects. II) Since needs of the future will require a great increase in the number of scientists, plans for extending basic research in any field should be supported by measures designed, coordinated, and put into operation in the educational system of each country for increasing the number of trained scientists able to carry out such research plans.

This two-volume report is an important and many-sided scientific document. From it one gains an over-all view of the pattern of modern scientific research and development as forming a huge triangle with "university science," "industrial science," and "government science" at its three corners. Science research planners, administrators, financial backers, laboratory workers, educators, and technical and popular science writers will all find the materials in these two volumes worthy of examination and discussion. The report is epochal in the field of assessment, survey, and planning for the advance of science and its applications. It is a model for the preliminary organization and conduct of such conferences, and the Royal Society has again, it seems to the reviewer, demonstrated foresight and outstanding leadership in creating and guiding the Empire Scientific Conference and in making its report available to the public.

WALTER R. MILES

Yale University

Liberty Hyde Bailey: a story of American plant sciences. Andrew Denny Rodgers, III. Princeton, N. J.: Princeton Univ. Press, 1949. Pp. 506. (Illustrated.) $7.50.

As these words are written Liberty Hyde Bailey is entering the 92nd year of his life, and is still collecting plants, both living and herbarium specimens, still publishing, still reaching out with his mind, at an age when other men, if they are able to think at all, have mentally "retired," with opinions formed and portals closed to the acquisition of any further and considerable body of knowledge. Not so this dean of American botanists, who once said that he had planned to take 25 years to study the science of botany, 25 to practice it, and 25 to enjoy it. Actually, he has, in each quarter-century since his majority, done all three things at once and is still learning, practising, and enjoying a science which no one in his day ever did more to encourage, broaden, and make vivid.

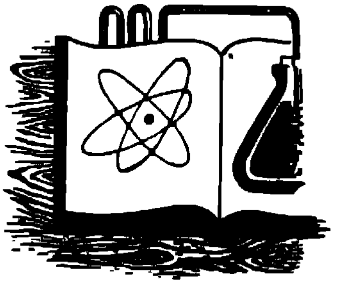
Many men have gone deeper in their branches of botany; no man in America was ever a better all-around botanist. Bailey is most famous, of course, as an editor, geneticist, and teacher, and as the first American to treat horticulture as a serious science, with the broadest social implications. But beyond all this he is a philosopher—having reached the highest thing any scientist can be—who brings together the varied interests of his own and his contemporaries' minds, and from them evolves not a schematic theory of the world as it ought to be, but an attitude toward the world as it is. A man who can accomplish this, and live, too, a happy and noble personal life like Liberty Hyde Bailey's has indeed fulfilled the high destiny that (we like to think) is the function of a man of science.

All this, and more, much more besides, has been told in *Liberty Hyde Bailey*, by Andrew Denny Rodgers, in the fifth title of his scholarly series of biographies that constitute a history of American botany from the days of Torrey and Mr. Rodgers' ancestor, Sullivant, and the era of systematics and exploration a century ago, down to the present with all its diversities and complexities. Those of us who, like the present reviewer, have read every word so far are grateful to Mr. Rodgers for the precision and breadth of treatment, and the understanding appraisal of the botanists who form the subject of his unusual sort of historical writing. At the same time it must be said that, as writing and as history this is, rather, reference work—the materials for a history. As biography it is a compilation—meticulous, thorough, and lucid—but not living portraiture. Nothing is omitted, nothing is highlighted; a reasonable monotone is the result. By comparison, passages from writings of Liberty Hyde Bailey, as quoted in this book, are so full of natural poetry and vitality of thought and phrase as to make one wish that Professor Bailey would write his own biography, even at the cost of further researches upon palms.

Yet we shall all look forward to further titles from Mr. Rodgers' pen. We hope that he will not only continue with his painstaking researches in the present era, but will carry the history of American botany back to the days of Linnaeus's American correspondents—Colden, Bartram, and Garden—and that he will take for his models in biographical writing such authors as Boswell, Macaulay, Fiske, and Parkman, whose scholarship never suffered from their artistry.

DONALD CULROSS PEATTIE

Santa Barbara, California



Scientific foundations of vacuum technique. Saul Dushman. New York: John Wiley; London: Chapman & Hall, 1949. Pp. xi + 882. (Illustrated.) $15.00.

This book is a monument to an era just concluded and a marker and a storage depot for the future. The era began with the invention of the condensation pump, and it ended spectacularly when vacuum went to war—high vacuum for radar and the fissioned atom, grand vacuum for magnesium and penicillin. During the intervening 30 years the gas-filled X-ray tube gave place to the Coolidge vacuum tube; the tungsten lamp and electronics came to maturity, and the molecular still was born. A regiment of subsidiary apparatus and measuring instruments sprang up and vacuum plumbing graduated from an unwelcome necessity to a hobby, then to an art, and recently to a science.

In 1922 Dr. Dushman published a little book called *High vacuum* which at once became the guide to a new territory. Shortly afterwards, many larger and more comprehensive books were written, mostly in the same pattern, but none placed the matter more succinctly. It has been evident for 10 years, however, that much new material has accumulated. It has been equally evident that the one man to make the authoritative compilation is Dr. Dushman because, as associate director of the General Electric Laboratories at Schenectady, he has witnessed or himself created nearly all that has transpired.

The *Foundations* is a reference book for scientists and advanced engineers; it does not deal with vacuum in the chemical process industries. The first four chapters—perhaps the best in a very good book—cover the theory of gases (and even the highest vacuum on earth still contains much gas). The next chapters on pumps and gauges are authoritative and comprehensive rather than selective. The later chapters dealing with adsorption, getters, solubility of gases in metals, and diffusion of gas through metals, are encyclopedic. On vapor pressure, the dry or electronic field is fully covered, but pump fluids only meagerly. The references and indexes are splendid. It is difficult to assess the merits of a book that has no rivals; suffice it to say that it stands alone. Practically every laboratory, regardless of its avowed purpose, will find a place for this book.

KENNETH C. D. HICKMAN

Rochester, New York

Quantum mechanics. Leonard I. Schiff. New York: McGraw-Hill, 1949. Pp. xii + 404. (Illustrated.) $5.50.

Schiff's new textbook *Quantum mechanics* will be a very great help to anyone who studies this fundamental subject, which by now is taught to every student of physics. There is no other field in physics which poses more and harder problems to the teacher. Explaining the fundamental concepts of quantum mechanics is the most difficult of tasks, and no really clear way of doing it has yet been found. However, every student must not only be acquainted with these fundamental concepts, but also be able to apply them in his research work. Quantum mechanics also uses a great number of very complicated mathematical formalisms to which the student must be introduced. This is the easier part of the course, and too little emphasis is usually given to the exposition of the fundamentals.

The present book is distinguished in this respect from most of the older, widely used textbooks. The first chapter contains a well-presented description of the fundamental concepts of measurement and complementarity. It introduces the reader into the problematics of the subject but does not relieve the more serious student from the study of books like the ones by Dirac or Kramers, and the classical papers of Bohr. The Schroedinger wave equation is introduced in the second chapter by using the experimental relation between frequency and wavelength. This emphasizes the connection with experimental facts, which is sometimes missing in more dogmatic representations. The following chapters are very much along conventional lines, but are written with great care and with emphasis on detailed and elegant derivations. The book differs from the usual introductions into quantum mechanics by a strong emphasis on collision theory. This is a great advantage in view of the increasing application of quantum mechanics to nuclear collision problems.

One notices a change in style beginning with Chapter 9, when the problems of many particles are treated and when radiation is taken into account. Less emphasis is placed on detailed description and the book takes on more of the character of a survey than before. These chapters include discussion of identical particles and the spin of the electron, and a semi-classical treatment of radiation and of the spectra of atoms and molecules. The last three chapters form a separate unit, on the relativistic wave equation, and the quantization of the wave fields, and a short introduction into quantum electrodynamics; they represent, therefore, what is taught in most schools in a separate course on advanced quantum mechanics.

A few details could perhaps be criticized from the point of view of the reviewer, who has probably acquired a too-narrow idea of how to teach this subject. One of the most important concepts for the understanding and practical application of quantum mechanics is angular momentum. The treatment of this concept could have been more extended. There is, for example, no reference in the book to the fact that the angular momentum operators are the operators of infinitesimal rotations. The addition of angular momenta as applied to many-particle problems is mentioned, but has not received a very thorough discussion. This textbook, as well as most of the others, refer the reader to the book by Condon and Shortley, whose treatment, however, is much too exhaustive—the reviewer has found that it frightens away most of the students who want to study it. It is hoped that some textbook will provide an elegant and simple treatment of this field. The spin of the electron does not get the attention it deserves. The fact that the electron wave function has two components is derived in too formal a manner. A discussion of the transformation properties of these components, if the coordinate system is rotated, is necessary for the understanding of the spin.

Schiff's book has many values for teachers and students, not the least of which is its collection of first-rate problems. Too few textbooks on quantum mechanics can be used for a graduate course. There are many ways of teaching the subject and there is a great need for textbooks with different approaches. Although the present book in many respects follows the conventional lines, it does bring in new ideas and approaches and will contribute to a better understanding and better teaching of quantum mechanics.

VICTOR F. WEISSKOPF

Massachusetts Institute of Technology

Physical aspects of colour: an introduction to the scientific study of colour stimuli and colour sensations. P. J. Bouma. New York: Elsevier (U. S. distributors for Philips Technical Library, Eindhoven, The Netherlands), 1948. Pp. 312. (Illustrated.) $5.50.

It is a pleasure to review this remarkable summary of the principles and techniques of modern measurement of color. Dr. Bouma spent the last two years of his life to produce what he knew would be his last work, and he has achieved a brilliant climax to a distinguished career in illuminating engineering.

Starting from a novel yet perfectly sound approach, Dr. Bouma presents the concepts and laws on which the measurement of brightness is based—the Maxwell color triangle and the standard ICI colorimetric coordinate system and its relation to dominant wavelength and purity, to color temperature, to boundary, ideal, optimal, and full colors, and its use in the reduction of spectrophotometric data. He then passes to visual colorimetry, defective color vision, discrimination of color differences, the Munsell color system, and hue and saturation of object colors in connection with chromatic adaptation of the eye.

Dr. Bouma does not skip over the hard parts, but goes in simple language to the knot of each problem, often with a mathematical proof. The book is further remarkable for its completeness. All important colorimetric techniques are not merely described; they are appraised with consummate skill and judgment.

In spite of the direct style and excellent translation into English, the book is not easy reading. It has to be studied, not merely read. The facts and concepts of modern colorimetry cannot be adequately grasped by the layman, however intelligent he may be, in a few hours. Here is a clear account of these facts and concepts by a world master whose comprehension of the recent extensive American literature will probably not be matched by an American author for some years to come. Dr. Bouma's book meets a unique and long-felt need, and should be available to every serious student of color.

DEANE B. JUDD

National Bureau of Standards

Practical spectroscopy. George R. Harrison, Richard C. Lord, and John R. Loofbourow. New York: Prentice-Hall, 1948. Pp. xiv + 605. (Illustrated.) $6.65.

The authors of this extremely useful and interesting reference book have operated in recent years the spectroscopic laboratory of the Massachusetts Institute of Technology and have felt (quoting from the preface) "the need of a text and reference book that would help the worker in any branch of science to evaluate the aid which the techniques of spectroscopy might lend to the solution of his problems. In our attempt to fill this need, we, as a physicist, a chemist, and a biophysicist, respectively, have tried to synthesize our three viewpoints in a way that would be useful to all who use, or might use, the techniques of experimental spectroscopy."

They have produced a book that will be valuable and interesting to all of us who have made constant use of the spectrograph, and will fulfill the requirements of the beginner as well. For example, in the chapter on the photography of the spectrum (page 154) I find a suggested routine to follow in transferring a plate from the box to the plateholder in a perfectly dark room, in order to be spared the embarrassment of finding, on turning up the lights, an open box of plates awaiting disposal.

The beginner will find in the first chapter a very brief history of the development of the spectroscope, its construction and operation, and its use in physics, chemistry, biology, medicine, metallurgy, food research, and criminology. Chapters 2 to 5 are devoted to the selection of spectroscopic instruments and the use of prisms and diffraction gratings, together with the fullest details on their adjustment and methods of illumination.

Chapter 7 covers the photography of the spectrum, dealing with practically everything connected with the selection and development of plates and with common defects in spectrum photographs and how to avoid them. Chapter 8 offers a very full description of the various types of light sources for spectroscopy, low temperature thermal emission, metallic arcs, high and low pressure mercury arcs, spark discharges, and vacuum tubes.

Chapter 9, on the identification of spectrum lines, measurement of wavelengths, and the determination of minute traces of impurities with the comparator, closes with a description of Harrison's remarkable automatic comparator, used at the Massachusetts Institute of Technology since 1938. This machine is capable of measuring in two minutes a spectrum plate 20 inches long on which are recorded as many as 2,000 spectrum lines. It records on a motion picture film, to seven-figure precision, the wavelengths in Angstrom units of all of the lines, along with a curve of density showing their position and intensity. Unfortunately, the record on the strip of film reproduced is on such a small scale that the numerals can't be read. This is also the trouble on page 163 in the case of the sensitivity curves of various emulsions.

Chapter 10 covers very fully the modern quantum theories of atomic spectral series, energy levels, and the Zeeman and Stark effects (the former effect furnishes a method of classifying lines into series). The chapter closes with a treatment of the Pauli exclusion principle and the periodic table.

Chapter 11 is devoted to describing the highly complicated fine structure of the spectra of molecules (their rotation and the vibration of their atoms give rise to corresponding energy levels, superposed on the electronic levels), and to explaining the part these energy levels play in producing various types of absorption spectra.

In Chapters 12 to 14 we are back again in the laboratory with 420 pages devoted to methods for measuring the intensities of spectrum lines or absorption bands by means of radiometers, photoelectric cells, and photographic emulsions. Some of the instruments are automatic, like the extremely complicated photoelectric spectrophotometer of Hardy, and the instrument of Harrison and Bently previously mentioned.

Chapters 15 and 16 deal with the qualitative and quantitative analyses of materials. In the two following chapters the treatment of infrared and "Raman" spectroscopy is far more extensive than is usual in books on general spectroscopy, and Dr. Lord's contrast and comparison of these two types of observation will be of great interest to everyone engaged in the study of molecular structure and in qualitative and quantitative chemical analyses.

A minor mistake was made on page 474 in crediting E. F. Nichols with the invention of the widely used method of residual rays, and not mentioning Rubens, who originated the method and named the radiations "rest strahlen." Nichols, who was working under the direction of Rubens, had found that a quartz plate had a very high coefficient of reflection in the region between 8 and 10 microns, but it was Rubens who foresaw that multiple reflections from a number of plates would eliminate all of the very intense radiations of shorter wavelength. Rubens developed the method and published it under joint authorship with Nichols. The description of the method of "focal isolation" of a narrow region in the remote infrared (described on the next page) omits mention of the very essential circular metal disk covering the center of the quartz lens or the fact that two such lenses are usually employed.

Chapter 19 covers the spectroscopy of the vacuum ultraviolet and presents diagrams of the vacuum chambers housing the optical parts. The final chapter offers a much longer treatment of interferometric spectroscopy than is usual in textbooks, covering the Lummer Gehrcke plate, Fabry and Perot's etalon, the Michelson transmission echelon, and the reflecting one of W. E. Williams.

The very complete references to specific points, in the form of footnotes, and the general references at the end of the chapters supply the details, often desired, but usually found wanting in a book like this, for lack of space.

R. W. Wood

Johns Hopkins University

Handbook of radioactivity and tracer methodology. William Siri. (With contributions by Ellsworth C. Dougherty, *et al.*) (Air Force Technical Report No. 5669.) Washington, D. C.: Office of Technical Services, Department of Commerce, 1948. Pp. 867. (Illustrated.) $20.00.

This handbook should be an invaluable aid to the many scientific specialists who wish to apply the use of radioactive or stable isotopes to the investigation of their special interest. I should say that it would be particularly useful to the biologist or chemist who needs these techniques but who has been handicapped by a lack of information about the physical methods which must necessarily be used for measurement of the appropriate rare isotope. Such an individual will find the necessary background information on nuclear physics in the first section of this handbook. This section also contains a wealth of range and cross section data which will be of particular interest to the physicist or biophysicist. The second section of the handbook is devoted to a discussion of the various instruments used for measurement of isotopes. The information in the chapter on calibration and use of G-M counters, as well as the detailed discussion on preparing biological samples for counting, is indispensable to the novice and probably could be read with profit by many of the more experienced workers in the field. The chapter on autoradiography is somewhat general and, in view of the rapidly expanding interest in this technique, the next edition of the handbook should perhaps treat it in greater detail.

A third section deals with the biological and medical applications of isotopes. The useful isotopes are discussed as regards their use in both tracer experiments and therapeutic applications. A chapter on the biological effects of natural radioactive elements closes this section.

The fourth section consists of an extensive bibliography including some general references and a complete list arranged according to the elements investigated.

In general it may be said that this handbook contains information available in no other single source. While particular stress has been laid on its usefulness to the biologist or chemist, it should be an invaluable reference for the graduate student in physics or biophysics as well.

The one respect in which this book fails to qualify as a bible for the beginner in radioisotopic research is its lack of a health physics section. This may be a calculated omission, based on the belief that the biologist or chemist must associate himself with a specialist in health physics if he wishes to avoid serious health hazards. However proper this attitude may be, and regardless of who makes the radiation measurements, it is the duty of any responsible investigator to inform himself about the radioactive hazards he and his subordinates might incur in carrying out their work. The widely spread use of radioactive isotopes may result in injurious radiation exposure if sufficient background information on health physics is not generally available. If this handbook becomes as widely distributed as its excellence deserves, it might well serve to supply this basic health physics information.

JOHN B. HURSH

Atomic Energy Project,
University of Rochester

Some aspects of the luminescence of solids. F. A. Kröger. New York-Amsterdam-London: Elsevier Publ., 1948. Pp. xi + 310. (Illustrated.) $5.50.

Although the war ended almost four years ago, conditions insuring an easy access and exchange of available scientific information have not yet returned. A great amount of valuable research has been done in some European countries during and after the war. However, because of the limited availability and circulation of European journals, the results of these researches are not widely known in this country. It is fortunate indeed that Dr. Kröger, who has contributed so much to the knowledge of the luminescence of solids, undertook the task of presenting in this monograph the results of his experimental researches and combining them with a critical review of the existing theories of the luminescence processes in solids. Dr. Kröger's association with one of the leading industrial laboratories,—the Philips Laboratories in Eindhoven, Holland—has enabled him to use freely all the rich resources of information amassed there in the course of many years of research.

The first chapter discusses schemes of energy levels for pure solids and for solids with lattices disturbed by the presence of impurities. A more detailed description is given of the atomic orbit approximation for the case of ionic lattices. Other topics are the processes of light absorption and emission, and the nature of metastable states of the activation, sensitization, and energy transfers through the lattice. Finally, a classification of all known luminescences of activated phosphors is attempted in the form of tables accompanied by very exhaustive references to original papers. The next four chapters consist of results of experimental work on particular systems—tungstates, molybdates, and luminophors activated by manganese, uranium, and titanium. The skillful identification of the tetravalent manganese ion as activator for the emission of a red band (Chapter II), and the correlation between the positions of the absorption edge and the maximum of the emission for tungstates and molybdates (Chapter III) are especially interesting. The sixth and final chapter compares the experimental results on the influence of temperature on efficiency of luminescence with the explanations of the quenching processes proposed by Mott and Seitz, Möglich and Rompe, and Klasens and Schön. It is shown that in some cases the excitation energy is directly transformed into vibrational energy (Mott-Seitz), in others the energy is dissipated via intermediate states (Klasens-Schön). A useful table of classification for all known types of temperature quenching is included. An appendix provides a few data on experimental techniques.

In general, the monograph is both interesting and informative. Great care has been exercised in both theoretical chapters to present a clear picture of the processes in solid luminophors and to establish a well-defined terminology for these processes. One section seems a little too condensed and could benefit by some additional explanations. This section deals with the energy level scheme. The use of expressions like "energy cost" (energy requirement) and "cheap transition" (low frequency transition), which are probably the result of a too-literal translation from Dutch into English, is unfortunate. In other respects the book is very readable and the reviewer feels that it fills an important gap in the literature on luminescence of solids. The successful effort made by Dr. Kröger to organize a considerable number of previously uncoordinated facts and correlate them with corresponding theoretical considerations is especially welcome in a field of physics where the richness of experimental data seems to be in contrast to the meagerness of our understanding of fundamental processes.

S. MROZOWSKI

Photoswitch Incorporated,
Cambridge, Massachusetts

Vision and the eye. M. H. Pirenne. London, W.C.1, Engl.: Pilot Press, 1948. Pp. xx + 187. (Illustrated.) 12/6.

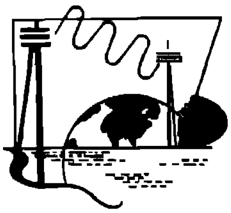
As noted in the foreword by W. S. Stiles of the National Physical Laboratory of England, this little book offers a treatment of selected topics in vision rather than an attempt to cover the entire field in its many ramifications. The subjects selected for treatment are apparently those in which the author has done research and made scientific contributions; this makes the book particularly authoritative and forceful.

The first five chapters discuss in detail the several phenomena involved in image formation by the eye, from the physical and physiological points of view. A lengthy treatment follows of questions relating to the way in which the particle or quantum nature of light enters as a factor in determining visual response, and the experiments of Hecht, Shlaer, and Pirenne are quoted and discussed in detail. The final third of the book is devoted to the subject of color vision, except for a single chapter which relates to binocular vision.

It is hard to see exactly what audience the author had in mind for this book, since some portions seem elementary whereas others are quite sophisticated. Surely it would not serve as a textbook, but rather as a reference book for those who are looking for a comprehensive treatment of certain important phenomena of vision, from the physical rather than the psychological point of view. The book appears to be in the tradition of that distinguished American biophysicist, the late Selig Hecht, a fact which will be appreciated by the many admirers of Hecht's work in vision.

STANLEY S. BALLARD

Tufts College



Microwave magnetrons. George B. Collins. (Ed.) (Massachusetts Institute of Technology Radiation Laboratory Series.) New York-London: McGraw-Hill, 1948. Pp. xviii + 806. (Illustrated.) $9.00.

As a result of the great program of work in radar that was set off by British success in exploiting the magnetron, a previously more or less familiar laboratory microwave generator, it is natural that a tremendous amount of information concerning it was accumulated during the war, both here and abroad, and in both university and industrial laboratories. This important volume of the M.I.T. Radiation Laboratory Series summarizes that knowledge in a very thorough manner. It will of course be of most interest and value to those who have had some experience with the device or are contemplating its use. With its great wealth and detail of material, this book will undoubtedly be the standard reference work for years to come.

For those who have little familiarity with the magnetron and want to know more, an introductory chapter summarizes some of the elementary facts about its operation. Following this introduction, the work is divided into sections: resonant systems, analysis of operation, design, tuning and stabilization, and practice. The last section includes not only details on the fabrication of magnetrons but also measurements of their properties and descriptions of some of the various types. Of necessity, the first two sections include much analysis which has a formidable look; these sections, important as they are, will consequently appeal to a smaller group of readers than the other more descriptive sections.

For all the variety of detail to be found in the book, there are nonetheless some omissions and some points too briefly discussed. For example, there is no discussion of two types of magnetron resonators that, although they are not used, practically every worker in the field invents at one time or another. There are other minor omissions —the problem of harmonic generation, the mechanical changes that may be produced in the resonator system by extreme operation, and the effects of cathode eccentricity. The cathode and magnetron life might have been more thoroughly discussed. Other widely used magnetrons, particularly those developed in England, with which the Radiation Laboratory was not so closely connected, might well have been included as typical magnetrons. A brief discussion of magnetron development in enemy countries during the war would have been illuminating and not necessarily irrelevant.

It is to be expected that such a work, done by many writers in short periods of time and in widely separated locations, should include errors. Those few that came to notice are errors in detail—references to material or sections not included or pictures mislabeled. This is all small criticism. *Microwave magnetrons* represents a very large task excellently done.

PAUL L. HARTMAN

Cornell University

Cosmic rays. L. Jánossy. Oxford, Engl.: Clarendon Press; New York: Oxford Univ. Press, 1948. Pp. xiii + 424. $10.00.

The investigation of cosmic rays since their discovery by Victor F. Hess in his balloon ascensions in 1911–1913 has become one of the most important branches of research in modern physics. Since 1926 the hypothesis of Hess as to their extraterrestrial origin has been accepted and proven to be correct. Numerous investigators, of all nationalities, all over the globe, are engaged in these researches, but aside from some brief monographs and symposia reports, this book by Janossy is the first compendium on cosmic rays. The author, senior professor in the School of Cosmic Physics at the Dublin Institute for Advanced Studies, has himself contributed many original investigations in the field during the last 15 years.

The book opens with an historical introduction sketching the trend of discoveries and the successive problematical changes. It discusses the penetrating power of cosmic rays, the question as to the nature of cosmic rays, the cosmic ray particles (positron and meson both discovered in the cosmic radiation by Anderson), the geomagnetic effects, and the question of the origin of cosmic rays, particularly the meson. The introduction thus serves as a summary and the various chapter headings follow this outline. Since cosmic rays are high energy particles the experimental technique for their detection and the theory of high energy interactions are discussed in some detail. Each of the experimental techniques—ionization chambers, counters, cloud chambers and the photographic plate method—is briefly described. (The photographic plate method, unfortunately, is discussed all too briefly; an appendix mentions some of the beautiful and important new experiments of Powell and his school at Bristol.)

A chapter on the theory of fast collisions serves as an over-all introduction and foundation for the theoretical discussion which follows in later chapters. This discussion is based on classical and semiclassical theories and the quantum mechanical treatment is omitted. Each chapter opens with a presentation of the experimental evidence, illustrated by tables and graphs; this is followed by detailed theoretical discussion, a comparison between theory and experiment, and an interpretation of the experimental results. An appendix on the statistical treatment of observations and auxiliary tables for the cascade theory computations will be useful to the research worker and student. The great compass of literature covered will make this compendium an invaluable help to anyone working in cosmic ray physics. It should be pointed out, however, that the student will have to make use of the original literature quoted, since so much is digested in the treatise that it is impossible to give detailed derivations for every formula.

It should be mentioned that, although the author addressed this book primarily to the specialist, he has followed it up with a small text for the general reader—*The frontiers of science series: cosmic rays and nuclear physics*—which will be useful to students as an introduction to the larger volume.

K. Lark-Horovitz

Purdue University

Vacuum tube amplifiers. (Massachusetts Institute of Technology Radiation Laboratory Series.) George E. Valley, Jr., and Henry Wallman. New York-London: McGraw-Hill, 1948. Pp. xvii + 743. (Illustrated.) $10.00.

This book, the 18th volume in the Radiation Laboratory series, discusses amplifier types that are used in radar systems, but are more generally applicable to the whole field of instrumentation, control, and special communication devices. It is recommended to engineers in these fields as a valuable reference and to others as a good introduction to the subject.

The introductory chapter treats the analysis of linear circuits by operational methods. Subsequent discussions cover video amplifiers; wide band, high frequency amplifiers; low frequency, band pass amplifiers; and direct-coupled amplifiers. In each case a theoretical analysis of pertinent circuitry is supplemented by a detailed exposition of design principles. Particular attention is directed to those factors affecting gain, band width, dynamic range, and fidelity of response. Much practical design advice is included. However, in some cases practical difficulties may not be sufficiently stressed. Inveterate optimists are warned against the suggestion (p. 193) that a stagger-tuned IF strip might be realized with only inductance tables, a soldering iron, and a pair of pliers. Final chapters cover the theory of amplifier noise, minimal noise design, and the measurement of amplifier noise.

The technical level of the discussion is uniformly high. The material presented is up to date and definitive of current design practice. Some of it has heretofore been available only in periodicals or in reports having limited circulation.

Excellent editing is apparent. The 14 chapters, separately written by 10 contributing authors, maintain very satisfactory continuity. Illustrations are plentiful and references adequate. The index appears too brief, but a detailed table of contents facilitates location of material.

J. G. Reid, Jr.

National Bureau of Standards

The face of the moon. Ralph B. Baldwin. Chicago: Univ. Chicago Press, 1949. Pp. xiv + 239. (Illustrated.) $5.00.

Over a period of several years, Dr. Baldwin has been studying the moon's surface particularly from photographs made at the great observatories, and his conclusions have been set forth and justified in his new book. His contention is that meteorite impact is solely responsible for all lunar features except the obvious blowholes that are lined up in curving rows in many regions of the moon. Lunar lava has altered many of the features thus produced by impact, but even the great Mare Imbrium, "tolerably circular," and 700 miles in diameter, is included as an impact explosion crater.

His too-rapid dismissal of slow igneous processes, in which he largely falls into the usual error of comparing lunar formations with present-day terrestrial volcanoes, will hardly serve to convince those who continue to wonder how craters 50 or even 100 miles in diameter can be only two or three miles deep, if formed by meteoritic bombardment. He discusses this problem in a chapter on "correlations," but somehow it doesn't quite convince. The violence of an impact explosion would have been so great that large craters, whose walls would be below the horizon for an observer at the center, could hardly have been formed. On a plane surface, perhaps it would be possible, but the moon's surface is too sharply curved.

But Dr. Baldwin's book is the only modern comprehensive championing of the impact hypothesis, which was advanced casually and intuitively in the past. No one has more intimately studied the lunar surface, with a view toward demonstrating the truth of the impact hypothesis, nor, for that matter, has anyone so completely discussed the terrestrial meteorite craters. In two chapters totaling 50 pages, Dr. Baldwin has given a very valuable description and discussion of the known and suspected impact craters on our own planet. It is somewhat amazing, however, to find him quoting, with a straight face, the weird "contraterrene" hallucination of La Paz, in connection with the great 1908 Siberian meteorite fall.

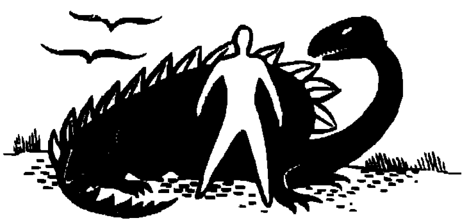
Other important sections of the book are his discussions of the lunar atmosphere and hypothetical lunar history during the period outlined by the theory of tidal evolution. This latter section is a very well thought out attempt to account for the obviously different ages of the lunar features.

It is a good and valuable book, and it does not matter that it will not convert many who now believe in an igneous origin of the lunar craters. Any discussion of the moon's features by someone as thorough as Dr.

Baldwin is a welcome contribution to the somewhat neglected astronomy of the solar system.

ROY K. MARSHALL

University of North Carolina



Island life: a study of the land vertebrates of the islands of eastern Lake Michigan. (Cranbrook Institute of Science, Bull. No. 27.) Robert T. Hatt *et al.* Bloomfield Hills, Mich.: Cranbrook Institute, 1948. Pp. xi + 179. (Illustrated.) $4.00.

Insular plant and animal populations have always held a peculiar fascination for the student of natural history, partly because they provide opportunity to observe, record, and deduce without the harassment of the almost innumerable impinging factors that must be reckoned with in a comparable mainland study. Here there is land, there, water; the boundary line is sharply drawn, confining the terrestrial fauna, for the most part, within the area it circumscribes.

Island life is a progress report presenting the results of seven years' study of such an insular fauna. The study, jointly sponsored by the Cranbrook Institute of Science and the University of Michigan, covers 17 islands lying off the Lower Peninsula of Michigan. Mammals, birds, reptiles, and amphibians are considered, both as to distribution and as to habits that have effected the presence or absence of certain forms.

The study is well conceived, particularly in that it includes research into the geological and cultural history of the islands. The geological history, specifically the postglacial history, indicates that, following the recession of the glacial sheet, the water level dropped to around 200 feet below its present level. This provided land bridges between the islands and the mainland, but there seems little evidence from the faunal lists that these land bridges contributed materially to the distribution of the various vertebrates considered. In part, this may be due to the fact that the lake level subsequently rose around 300 feet, covering all the smaller islands, and the bulk of the larger ones. In any case, the authors hesitate to ascribe the present distribution of any form primarily to land bridge invasion.

The cultural history is interesting to the extent that man has superimposed certain introduced species (gray and fox squirrels, raccoon, and deer) extirpated others (elk, cougar, wolf, bear) and provided temporary haven for certain of man's common commensals (house mice, wharf rats, and English sparrows). The greatest single human influence seems to have resulted from the cutting of the original forest, opening the islands to many edge-dwellers that would not otherwise be there at all.

Just how the majority of terrestrial vertebrates reached the islands is open to speculation. Some undoubtedly came of their own volition—over the ice, through the water, or through the air. Some may have come via the land bridges. It is probable that some came in by drift, and evident that others were brought in by man.

The authors have been thorough in their consideration of the material at their disposal. However, one cannot help but feel that the summation may have been somewhat premature. Nearly every page poses questions that must go unanswered pending further investigation. It might be wished that one of the participating institutions would set up a permanent biological station on some one of the islands, and embark upon a 10- or 20-year program of study. Only thus could such phenomena as the relative paucity of species on the islands, as compared to the mainland, be explained. Even the largest island, Beaver, 58.4 square miles in area, and with nearly the same number of plant communities as the mainland, sustains less than one third the number of animal species.

As a progress report, *Island life* is excellent. It is well illustrated, the faunal lists are well annotated, and the analyses of the results to date are intriguing. As a stimulant to speculation and to further research, it is outstanding. The serious ecologist and vertebrate zoologist might ask for a more detailed record of specimens, localities of collection, and habitats, perhaps with maps. Such an expansion of the work would have made it more valuable to future field workers.

DONALD M. HATFIELD

Berkeley, California

Studies on bats and bat parasites. Olof Ryberg. Stockholm, Sweden: Univ. Lund and Zool. Lab. Agr., Dairy, and Hort. Inst. of Alnarp. Pp. xvi + 330. (Illustrated.)

This voluminous publication is taken from a greater study of many years' duration. It is largely a biological account or natural history of Scandinavian bats, but the information is equally relevant to the study of North American or other bats. Thirteen pages and eight plates deal with bat parasites and these chiefly the ectoparasitic *Diptera* of the family Nycteribidae.

The geographical distribution of bats of the world is dealt with by families in the text and in individual maps. Detailed maps are given for north European species. It appears that there are very few records of bats' approaching the Arctic Circle. Few, if any, occur in strictly polar regions, and none apparently in the treeless tundra, where these predominately cave and arboreal mammals could hardly be expected to be found. Ryberg remarks on the difficulty of establishing the northern limit of bat distribution in Siberia because of the "inaccessibility of the Russian literature." In Iceland bats occur only as stragglers, two North American species having been taken during the second world war. Few species occur at the southern tip of South America and none on the Falkland Islands. A compilation of altitudinal records shows few above 10,000 feet (3050 meters) with two doubtfully at 16,395 feet or 5000 meters, snowline on the peak of Mt. Orizaba, Mexico and near snowline in the Himalayas. This is curiously similar to the altitudinal distribution of ants.

Of the 17 families of bats comprising some 2000 known forms, hibernation takes place mostly in Vespertilionidae and in a few species of four other families.

The author reared bats successfully on a diet of *Tenebrio molitor* larvae with added vitamins. The Scandinavian species are all insectivorous and all drink much water. They fly to water surfaces and repeatedly dip the snout into the water as they fly over it. Besides their supersonic sounds the bats make buzzing sounds while flying and in connection with other activities, such as eating or sneezing.

The valuable embryological data include what is stated to be the first certain observation of triplet birth in the Old World. The author believes that he has obtained unquestionable evidence of pregnancy in the spring following fertilization in the autumn.

The plates consist of a heterogeneous assortment of small photographs, some not clear. They show very well, however, the nesting sites and the general habitus of the Scandinavian bats. A photograph of twin bats with only four instead of five toes is stated to be the first known case of hypodactylia.

The bibliography of 41 pages deals with world literature and is an important asset.

The author is to be congratulated on this excellent monograph, and it is to be hoped that the investigations on broad biological problems and parasites will continue. The University of Lund deserves credit for undertaking the publication of what in this country would be an expensive book.

NEAL A. WEBER

University of North Dakota

The avian egg. Alexis L. Romanoff and Anastasia J. Romanoff. New York: John Wiley; London: Chapman and Hall, 1949. Pp. xiii + 918. (Illustrated.) $14.00.

The title establishes the theme of this volume but it does not suggest its encyclopedic nature. As the authors state: "This book represents an attempt to compile all the facts known about the bird's egg." Their findings have been arranged into three main divisions: morphogenetic expression, biophysicochemical constitution, and bio-economic importance. There are 424 figures and a wealth of tables. The bibliography contains over 2,500 references, but unfortunately does not include the titles of the articles.

The book is written in clear and simple language and may be unstintingly recommended to a broad spectrum of readers, from the research worker to the laity. Serologists may be a bit annoyed at the references to "immunological" properties, and the bacteriologist will probably chafe because of the somewhat superficial coverage of the chick embryo, since the bibliography contains no citations of the work by Woodruff and Goodpasture or F. M. Burnet. But the book fills a real need.

MALCOLM H. SOULE

University of Michigan

Faune de France: Hyménoptères Tenthredoïdes. (No. 47.) L. Berland. Paris (VIe), France: Paul Lechevalier, 1947. Pp. 496. (Illustrated.) 1,500 fr.

This well-illustrated volume is the fourth monograph on Hymenoptera contributed to the *Faune de France* by the versatile and indefatigable Lucien Berland. Like the other three, which treat of the aculeate Hymenoptera exclusive of ants, this descriptive work on sawflies will prove a very useful adjunct to the American entomologist's library.

Following a very brief review of the morphology and biology of adult and larval sawflies, Berland enters upon the taxonomic analysis of all families, genera, and species of sawfly known to be represented in the fairly rich fauna of France or its immediate environs. The diagnoses are concise and lucid, and in the case of genera are generally supplemented by very satisfactory illustrations of the habitus of one or more included species, or of the anatomical characters employed in the keys. Appended to the descriptions of most genera are brief notes on the biology (generally food habits) and world distribution of their representatives. Where possible, much more extensive notes are given for each of the more than 500 species described. These include not only records of food plants and feeding habits of larvae, brief descriptions of larvae, sites of cocoon formation, parthenogenesis, and so on, but also extensive lists of parasites. Very valuable to the entomologists interested in the comparative biology of European and American sawflies is the careful and detailed documentation of these notes, a fact partially accounting for the large bibliography of about 500 references.

Supplementing the text are tables of information that are of special interest to collectors, economic entomologists, and more general biologists. There is a list of French sawfly species whose parthenogenetic attributes are known or conjectured, a list of sawflies known to be harmful to cultivated plants, and finally a list of plants, whether of economic importance or not, with their known sawfly consociates. A systematic index of more than 30 pages concludes the work.

As stated earlier, this book will be quite useful to students of the taxonomy of American sawflies. Representatives of about three-fourths of the more than 90 genera figured by Berland are found in this country, and Berland's illustrations of the habitus of numerous species will prove welcome supplements to the figures of isolated anatomical parts illustrating H. H. Ross's superb and indispensable *Generic classification of the Nearctic sawflies*. It is to be hoped that one day someone will do for the American fauna what Berland has done so well for that of France. Aside from MacGillivary's almost useless treatment of the Tenthredinoidea in the *Hymenoptera of Connecticut*, there is still no single modern taxonomic work dealing with the classification to species of sawflies for any state, or sizable locale, in the United States.

KENNETH W. COOPER

Princeton University

Wildlife management: upland game and general principles. Reuben Edwin Trippensee. New York-London: McGraw-Hill, 1948. Pp. x + 479. (Illustrated.) $5.00.

Workers and students in the field of wildlife management have long looked for a textbook to report the information that has so rapidly accumulated since the publication in 1933 of Aldo Leopold's classic *Game management*. Trippensee's work accomplishes this purpose admirably in several phases of the field.

Dr. Trippensee has been a wildlife research worker and teacher for 20-odd years in the Lake States and New England. His discussions of wildlife problems and bibliographies amply reflect this long period of work.

About four-fifths of the text is devoted to discussing three broad classes of wildlife—farm, forest, and wilderness—and to summarizing information on the ecology and management practices for the various species of wildlife considered as typical of these broad divisions. In general the information is well presented, though its order offers some problems. For instance in describing the technique of "Evaluating the Rabbit Range" on page 34 it is suggested that the reader turn first to the section on "Evaluating the Pheasant Range," some 42 pages later. The material for the Lake States area is much better than that for the western or southern sections of the United States.

The remaining fifth of the book deals with "Miscellaneous Wildlife Relationships" and "Wildlife Administration." These two sections are in the main adequate and sound summaries of predator problems, game harvest, refuges, winter feeding, administration, and technical training in the field of wildlife management. However the chapter on variations in animal numbers seems inconclusive to the reviewer.

After defining cycles in a way that seems to ignore quantitative data (he speaks of "noticeable scarcity" and numbers that "attract attention" in referring to population densities) Trippensee seems to argue around the question, through constantly leaning towards the "cosmic theory" as a basis of cycles in animal numbers. By using averages, he may well have masked the variations in time between dates of periods of abundance. Much of the data presented indicates both a lack of uniformity in time interval and also a lack of uniformity in the causes of decline in animal populations. In view of this, the term "cycle" as he uses it has little meaning in the commonly accepted sense of the word.

The reader will note that such important forms of wildlife as migratory birds and fur-bearers are not mentioned in the review. Trippensee states that "these, with a section on game fishes, were written but not published because of the difficulty of publishing and marketing as large a volume." It is hoped that these sections will be made available at a later date.

WILLIAM H. MARSHALL

University of Minnesota

Larger imperforate Foraminifera of South-Western Asia: Families Lituolidae, Orbitolinidae and Meandropsinidae. Francis R. S. Henson. London, S.W. 7, Engl.: British Museum (Natural History), 1948. Pp. xi + 127. (Illustrated.) 1£ 10/-.

This work is on the Foraminifera of a relatively new area. Very little has been published on the older formations of this region. The Foraminifera of only three families are included, one of which is new. Besides this, 14 new genera, 27 new species, and six new varieties are described. The various forms have complex internal structures and the plates show many thin sections to illustrate these structures. A glossary of the many special terms is included, and keys to the genera of each of the three families are given. Detailed text figures show developmental stages and the relationships.

The development and phylogenetic relationships of various forms belonging to these three families are discussed in detail and add much knowledge to the early developmental stages in these complex forms. The bearing of these stages on the evolutionary development is quite complex and much is still to be discovered regarding their usefulness in determining the true relationships of the various genera and their position in a true classification of the groups. Many gaps are yet to be filled in by future studies. These discussions of the various stages and their relationships to one another and to stages of other groups should make a decided advance in our knowledge of the three Foraminifera families concerned. The work should inspire others to add to our knowledge and to check the various relationships.

JOSEPH A. CUSHMAN

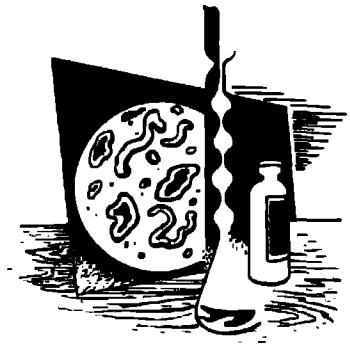
Sharon, Massachusetts

Animals without backbones. (Rev. ed.) Ralph Buchsbaum. Chicago: Univ. Chicago Press; London: Cambridge Univ. Press, 1948. Pp. xii + 405. (Illustrated.) $5.00.

No one will be as startled or as excited about this new edition of a highly successful text as people were about the book in its original form in 1938; the novelty of the excellent illustrations and simple, direct style has worn off. Yet it is clear that while the former edition was going through its seven printings, Dr. Buchsbaum was busy finding ways to improve his book. The new version has grown by only 34 numbered pages, and most of this is in an added final chapter entitled "Further Knowledge." In this new section and the accompanying four new pages of gravure photographs, the student is introduced carefully to such helpful material as information on biological field stations, scientific journals, and bibliographic procedure. A selected list of journals, advanced texts and treatises, and books on special aspects of the invertebrates is followed by a reprint of three scientific articles in their original form: "The Characters of *Pelmatohydra oligactis*" (Pallas) by Libbie H. Hyman: "Notes on Locomotion in *Pelomyxa carolinensis*" by Charles G. Wilber; and a short piece by W. L. Doyle and E. K. Patterson, "Origin of Dipeptidase in a Protozoan." These are presented in such a way as to encourage the student to make further acquaintance with biological literature.

Significant additions have been made to the photographic presentation of protozoans, sponges, and protochordates. New pictures of *Peripatus* and *Liguus* are especially striking. Photographs of living material have replaced pictures of museum models in several instances, and better cuts have been prepared from previous illustrations. Often the rearrangement of earlier illustrations has been surprisingly helpful, as for example in the case of the photographs of trapdoor spiders and nests. Only one cut, showing a pair of fruit flies, struck the reviewers as below the high standards set elsewhere. Better placement of the gravure pages, to correspond more closely with the text material, is another important improvement. All gravure pages now are numbered for easy reference; the new index draws attention to each illustration in its proper place.

LORUS J. and MARGERY J. MILNE
University of New Hampshire



Bacterial and mycotic infections of man. René J. Dubos. (Ed.) Philadelphia-Montreal: J. B. Lippincott, 1948. Pp. xiii + 785. (Illustrated.) $5.00.

Viral and rickettsial infections of man. Thomas M. Rivers. (Ed.) Philadelphia-London: J. B. Lippincott, 1948. Pp. xvi + 587. (Illustrated.) $5.00.

The first book, like its companion volume on viral and rickettsial infections of man, represents the combined efforts of several specialists in the field of infectious diseases to present a source of information primarily for medical students—in this case on bacterial and mycotic infections. As such, it may be considered a textbook of medical bacteriology.

Using the approach so ably elaborated by Theobald Smith, the stated emphasis is on host-parasite relationships; the biological characteristics of the invaders, the total response of the invaded, and the forces, natural and artificial, which may alter the balance in favor of the host are integrated to complete the picture. The first nine chapters, devoted to a consideration of general background such as history, the nature and properties of bacteria, the problems of infection, and the fundamentals of immunology, serve to elucidate the general philosophy of the book. The major part of the book, 25 chapters, dealing with a consideration of groups of bacteria and fungi with their special characteristics and disease-provoking potentialities, and therapeutic considerations of their clinical effects, presents a well-rounded picture of standard infectious diseases. Four concluding chapters consider sterilization, chemotherapy, epidemiology, and diagnostic procedures in general.

The book is printed with large type on hard finish paper which is well suited for the illustrations. Unfortunately, the size of the book is somewhat awkward; a single-column format with smaller pages, even though necessitating a thicker volume, would be easier to use.

On the whole, the book meets some of the needs of medical students. Representing as it does the work of many individuals, it might be expected to be more unevenly presented; that there is so little unevenness is to the credit of the editor. A few chapters suffer from too great a tendency toward a monographic style, and whereas they are excellent reviews for the specialist, they seem to be more involved than necessary for the beginning student. There is some minor duplication of material, but the different approaches of the authors prove stimulating. The chapter on the streptococci may be singled out as an excellent, up-to-date, and comprehensive review of an involved subject, presented in an exceedingly stimulating manner.

The bibliographies are adequate, but not as complete as might be desired.

This book should be of value to students, and could serve as a textbook; but its greatest worth, in the reviewer's opinion, will be as a reference volume for the initiated rather than as a primary source of information.

The field of human viral and rickettsial infections differs from the strictly bacteriological field in that it is not so well stabilized and also there has not been a plethora of textbooks on the subject. For these reasons the second book reviewed stands somewhat apart from its companion.

The subject is introduced in five chapters covering the nature of viruses and the techniques available for their study. A chapter on epidemiology stresses the special features of viral diseases but also covers the general problems of infectious disease transmission. A chapter on bacterial viruses, while not contributing directly to an understanding of human disease, is definitely in order as an aid to understanding virus behavior in general. The remainder of the 37 chapters cover in detail the specific human diseases caused by well-established viral and rickettsial agents, together with a few, such as exanthem subitum and infectious mononucleosis, for which the etiologic factors are still somewhat vague. In each case, a well-rounded picture of the clinical condition, the known facts about the causative agent, and diagnostic procedures are brought together.

Although the book was written by a number of specialists, there is excellent uniformity of approach and evenness of presentation. The material is up to date and the coverage adequate. Since this book has but a single rival in its field as a recent source of the material, it might receive strong recommendation on the basis of relative cost; however, on its own merits it can be enthusiastically suggested as a solid foundation for anyone desiring a well-balanced presentation of the subject. It most definitely fulfills the need of a book on this subject for the medical profession, mature and neophytic, and it will be extremely valuable for the developing specialist in viral and rickettsial science.

WILLIAM S. PRESTON

University of Michigan

Dictionary of genetics: including terms used in cytology, animal breeding and evolution. R. L. Knight. Waltham, Mass.: Chronica Botanica; New York: Stechert-Hafner, 1948. Pp. x + 183. $4.50.

As an extreme example of the difficulties met with by readers of the literature of genetics and cytology, Franz Schrader, in his book *Mitosis* (1944) lists 27 terms that have been used by writers in English for a single minute specialized region (*spindle-attachment, centromere, kinetochore*, etc.) of the chromosome. As he states, his list is not complete. All will agree with him that there is no point in keeping alive the many names that have been applied to this small object since its first description 50-odd years ago.

Knight refers to this structure in his preface, where he lists nine of the 27 terms, plus a new one. He apparently had not seen the book *Mitosis*, since Schrader's name does not appear in the bibliography. We must also agree with Knight when he says that genetic literature would be more readily understood if writers had, where possible, used an existing term instead of coining a new one, and when he expresses the hope that writers will not continue to coin new words where suitable terms already exist. Now we may ask, how does Knight as a lexicographer meet the problem of synonymy; in particular how does he handle the chromosome region just mentioned? Wilson, in his classical work *The cell in development and heredity* (1925) called it the *spindle-attachment* and got along with this one term: neither in his index nor in his glossary does he give any of its 27 synonyms.

Turning to the body of Knight's *Dictionary* for an answer, one finds *spindle-attachment* listed and defined. Checking the other nine terms listed in his preface we find four—*attachment constriction, centromere, insertion region*, and *kinetic constriction*—alphabetically listed and defined. The definitions are in almost the same words as for *spindle-attachment*. Cross references indicate that the author considers these five terms as synonyms. The remaining five of the nine terms are listed alphabetically, and after each the reader is referred for a definition to one of the four terms just mentioned.

Although such duplication of definitions is not a general feature of the book, conservation of space might justify printing the definition once and listing all known synonyms, followed in each case by a cross reference only.

One cannot avoid speculating as to what brought about the profuse growth of synonyms in this glaring instance, as well as in the literature of biology in general. The origin of new terms for old objects may be in part adaptive change: the new terms may express more truly than the old the real nature of the entities. The term *spindle-attachment*, as used by Wilson, was accurate and descriptive so far as it went. But during the past 25 years some progress has been made toward understanding the object, both structurally and physiologically. Cytologists now agree that it is more than the region of spindle fiber attachment. Rather, it is regarded as a differentiated chromosomal structure which plays a dynamic role in the movement of the chromosomes during mitosis; hence *kinetochore*, a term suggested by Moore and recommended and used by Sharp in his *Introduction to cytology* (1934) and his *Fundamentals of cytology* (1943) is more descriptive.

Perhaps another cause for the multiplicity of synonyms among English-speaking biologists is isolation. Geographical or psychological isolation may account for the preference of British cytologists for the term *centromere*, introduced by Darlington in 1936, although it is admitted that this term is in many cases not an accurate one so far as indicating the linear position of the structure in the chromosome is concerned. The centromere may reside at any point along a chromosome except the extreme end.

The minting of unnecessary terms probably results also from the relative indifference of some authors to the interests of their readers—not to mention the possibility of their own occasional conceit or vanity.

Knight's *Dictionary* is not limited to modern terms, because, as the author states, students still read and need to understand the older books. Including older terms will, he hopes, help to deter authors from putting new meanings on established words.

For some of the entries, definitions are taken directly or with slight changes from the works of others. In these cases the original authors' names are added. It is not apparent to the reviewer why the names of some authorities are followed by dates and others are not. References to the 125 authors cited are given in the bibliography. The *Dictionary* contains about 3,000 entries. Derivations of terms are not given; nor are pronunciations.

Recalling the aphorism of Dr. Johnson that "Every other author may aspire to praise: the lexicographer can only hope to escape reproach," it is inevitable that critics will take exception to some of the definitions as well as to certain omissions and inclusions. This is anticipated by the author in his request for additions and corrections for subsequent editions. In general the definitions strike the reviewer as clear and concise. Very few outright errors have been noted in a sampling of numerous pages. The reviewer intends to take the author seriously and send suggestions to him. Since the best of dictionaries, like the best of other compilations, are those that have been subjected to rigorous criticism, biologists will be performing a service to students and writers by giving Dr. Knight the benefit of their ideas.

Twelve pages of appendices constitute a valuable feature of the book. These include numerous commonly used statistical formulae and tables, among them a table of chi square that is more extensive than similar tables in most text books. There is an unusual table of "Distances Recommended to Avoid Seed Contamination," compiled from the recent literature. The book is attractively made up and is printed on a heavy grade of paper in clear and legible type.

EDWARD C. COLIN

Chicago Teachers College

General cytology. E. D. P. DeRobertis, W. W. Nowinski, and Francisco A. Saez. (Trans. by Warren Andrew.) Philadelphia: W. B. Saunders, 1948. Pp. 345. (Illustrated.) $5.50.

This readable and well-illustrated short text, originally published in Argentina, achieves a remarkably broad survey of modern cytochemistry, cell physiology, and cytogenetics. Its emphasis on cytoplasmic structure and the activities of "resting" cells reflects the profound shift in interest in the 25 years since Wilson's summary of classical cytology, with its concentration on chromosomes in dividing cells. Noteworthy features are accounts, previously reviewed only in symposia and monographs, of recent work on secretion, chromosome structure, "ultrastructure," membane permeability and enzyme systems, and descriptions of many ingenious techniques of physical and chemical cytology (occasionally emphasized at the expense of results or interpretations). In the reviewer's opinion, however, the book's principal contribution is pedagogical: The presentation of cytology as the synthesis of related facts customarily scattered through courses in "cytology," histology, physiology, biochemistry, genetics, and embryology. That the unity actually achieved is far less than ideal is no argument against either the validity of the innovation or the need for such a course at the senior or beginning graduate level. Rather, it is a challenging commentary on our state of knowledge.

The book is reasonably free from the twin curses of cytology: excessive and esoteric terminology, and "explanation" by definition or redescription. Each chapter has an up-to-date though incomplete bibliography. The emphasis is more zoological than botanical. The translation is clear, if not always polished. Occasional prominence given the authors' own work reflects their enthusiasm and directs attention to research in Latin America. Critical readers will note: a fair number of minor errors; omission of some pertinent modern contributions, for example, in the experimental analyses of cell division and of radiation effects; acceptance of some recent work with less reservation than perspective may justify; hypocritical embrace of certain Darlingtonian hypotheses; and inclusion of much primarily genetical material. However, such defects are remediable by a good teacher, and do not obscure the wealth of well-considered and accurate information presented. Few will agree that "Purely morphological cytology . . . has exhausted the study and description of various cellular structures," but also few will deny that here a stimulating step is taken toward the integration of biological, physical, and chemical data which must ultimately give us a unified and meaningful concept of the structure and functioning of the living cell.

JOHN B. BUCK

National Institutes of Health

Nucleic acids and nucleoproteins. (Cold Spring Harbor Symposia on Quantitative Biology, Vol. XII.) Cold Spring Harbor, N. Y.: Biological Laboratory, 1947. Pp. xii + 279. (Illustrated.) $7.00.

This volume is the second symposium on nucleic acids to appear in print within a year (cf. *Symposia Soc. exp. Biol.* Vol. 1). This coincidence reflects the current wide interest in nucleic acids as an important cell constituent and a possible key to some of the fundamental problems of cellular biology. Although the contents of the two symposia overlap in part, the wealth of material and the fluid state of research in this field, as well as the absence of definitive conclusions, make duplication a rather desirable feature. The reviewed symposium, organized by M. Demerec, included contributors from Belgium, France, England, Sweden, and the U.S.A.—among them J. M. Gulland. The volume is dedicated to this distinguished biochemist, who lost his life a short time after the meeting.

The 25 separate articles can be grouped into five major sections. The first deals with problems of the chemical and physical constitution of nucleic acids (NA) and nucleoproteins (NP). The structure of NA as a polynucleotide is discussed by Gulland in the light of the results of careful titrations. Taylor, Greenstein, and Hollaender report the effect of X-rays on the state of polymerization of NA, and the effect of ionizing radiations on various preparations of nuclear material is investigated by Errera. Enzymatic degradation as a tool of constitution analysis of NA is described by Greenstein, Carter, and Chalkley; and by Schmidt, Cubiles, and Thannhauser. Michaelis deals with the interaction of NA with basic dyes, correlating the spectral properties of the dyes with their degree of polymerization. For various reasons the chemistry of histological reactions has been notoriously neglected, and it is encouraging to find that the same author who in 1902 wrote a textbook that was probably one of the first introductions to the chemistry of histological staining is returning to this field.

Another group of investigators is concerned with the distribution of NA and NP in cells and tissues. Besides his own findings, Davidson includes data of several other authors on the NA content of mammalian tissues and of tissue cultures. Schneider compares the NA content of liver, regenerating liver, and hepatoma, and extends the determinations to separated cell parts like mitochondria and nuclei. Remarkable progress seems to be taking place in elucidating the composition of the chromosome.

This is borne out in studies on isolated nuclear components by Mirsky, Pollister, and Ris, and in histochemical studies by Serra, Schultz, and Mazia, Daniel, Hayashi, and Yudowitch. The presence of the Stedmans at the symposium, and their discussion of nonhistone proteins in the chromosome, give hope that a long controversy is on its way toward resolution.

The role of NA and NP in the biology of bacteria is considered by Belozersky and by Chargaff. Boivin presents his results on the production of mutations in colon bacilli by specific desoxyribose-nucleic acids and proceeds to an interesting discussion concerning the purity of his preparations of NA. The effect of chemical mutagens on bacteria is discussed by Witkin.

The possible significance of NA and NP in the embryonic development of organisms receives consideration by Brachet and Thorell. These authors deal with the possible function of NP as organizer and the changes of NA content in differentiating tissues.

An important phase in the current investigation of NA and NP is their relation to virus reproduction and to the synthesis of proteins. This field is covered by Knight, Hydèn, S. S. Cohen, and Spiegelman and Kamen. The papers of the last three authors deserve attention because of their objections to an oversimplified interpretation of the relation of NA content to protein synthesis in cells.

This volume has been a valuable aid to the reviewer in the course of his research on related topics—by the stimulating comparisons suggested in its widely different approaches, by its critical discussions, its reference lists, and its index. The subject selected for discussion and the high standard of contributions make this symposium a worthy continuation of the series. One is inclined to keep the volume near at hand at the laboratory. Swimming in the swift waters of present research on nucleoproteins, one may regard this book as an anchored raft on which to catch one's breath and gain enough distance from the currents to set one's own course.

HEINZ HERRMANN

Yale University

Investigations of human requirements for B-complex vitamins. Max K. Horwitt, Erich Liebert, Oscar Kreisler, and Phyllis Wittman. Washington, D. C.: National Research Council, 1948. Pp. v + 106. (Illustrated.) $1.00.

Because it is costly and difficult to measure man's physiological needs with quantitative precision, few such measurements have been made. There are very few estimates of continuing needs through periods long enough to stabilize body storage at fixed levels. In the present study, which sets a record for length of observation, experimental subjects were kept under controlled conditions for three years.

Detailed studies are reported on 36 men, 21 of them old and 15 young, who were kept on diets containing graded amounts of thiamine and riboflavin. The results are not dramatic but they indicate that 400 micrograms of thiamine is below the minimal daily requirement of inactive men; that the aged are less resistant than the young to restriction of B vitamins, although their optimal requirements do not appear higher; that a restricted intake of thiamine tends to intensify neurologic and psychiatric symptoms of the mentally infirm, but that a very liberal provision of B vitamins has no observable therapeutic value. A metabolic load test is described which promises to be useful clinically in the diagnosis of thiamine deficiency. It comprises mild exercise after oral glucose and immediate determination of lactic and pyruvic acids in the blood.

In epitome, the book reveals a careful, sober study whose value lies as much in its negative as in its positive findings. It illustrates both the possibilities and the difficulties of using the patients of mental hospitals for practical studies in nutrition. The authors, their sponsors, and the authorities of the Elgin State Hospital are to be congratulated for thoroughness and patience in an investigation requiring a high level of cooperation on the part of staff and subjects.

R. R. WILLIAMS

Research Corporation, New York City

Experimental immunochemistry. Elvin A. Kabat and Manfred M. Mayer. Springfield, Ill.: Charles C. Thomas, 1948. Pp. xv + 567. (Illustrated.) $8.75.

This book fills a particular need long felt by many workers not privileged to mature in the laboratories in which the science of immunochemistry was being molded. Drs. Kabat and Mayer, as students of Professor Heidelberger, have been instrumental in the development of this subject. The present book contains, "for the first time, in one place, the scattered techniques which have been developed to fill the needs of immunochemical problems."

In the first part we have the methodology of the antigen-antibody reactions. Here the quantitative immunochemical principles and methods are very clearly expounded and illustrated so that the student can apply these principles by analyzing for himself some of the numerous tables and graphs that have been compiled from the voluminous source literature. The book also serves as a laboratory manual with its many detailed procedures. Hence, from this section alone the book is an excellent accompaniment to an advanced laboratory course in the subject. Part II gives various applications and uses of the quantitative methods, such as assaying serological reagents and using quantitative methods in studying problems of homogeneity and cross reaction. Part III gives instruction in the special methods ranging from Kjeldahl nitrogen and phosphorus estimations to the more specialized physical biochemistry methodolgy. Part IV is a compendium of what might be termed "immunochemical preparations," giving methods for preparing substances of altered specificities, such as phosphorylated proteins, serum proteins and their fractionation, and various types of bacterial antigens. An appendix deals with the usual problems of bleedings, animal injections, glassware calibration, buffers, spectrophotometry, etc.

Experimental immunochemistry should be, therefore, of considerable value to those who work in the basic fields of preparative biochemistry and microbial metabolism

The manuscript submitted ran to over 400 pages. The book was set in type chapter by chapter. Early portions of the book were in galley proof before the end was set in type. The double column design adopted was modeled after the Journal of the American Chemical Society on the theory that chemists are familiar with this type of format. The small print for the experimental sections made further compression possible. The size of the book was chosen so that it would fit in the same shelves as the Journal of the American Chemical Society bound volumes. The book weighs five and one-half pounds. The entire cost of publication was borne by Princeton University Press. Dr. Clarke edited the American sections; Sir Robert Robinson edited the British sections and Dr. Johnson was responsible for the Index.

EVERETT S. WALLIS

Princeton, New Jersey

General endocrinology. C. Donnell Turner. Philadelphia-London: W. B. Saunders, 1948. Pp. xii + 604. (Illustrated.) $6.75.

There has long been a need for this book. Most texts on endocrinology have been written to fit the needs of the advanced investigator and physician, with no effort to interest a more general group of readers and afford them a good background and bibliography. This volume will probably do more to stimulate work in the field than many weightier and more specialized tomes.

Turner has fitted many of the arguable points into the first two chapters. His introduction, for example, includes a general survey of backgrounds and methods and the generalized features and glands of uncertain endocrine function. The second chapter is mainly centered about the biology of secretion, and here we find some strange companions such as chemical coordinators, inductors, and ovocators (embryonic), phytohormones, chemical mediators (nervous), autolyzing tissues, parahormonics, and vitamins. The space devoted to these components is not great and serves to advantage in bringing diverse phenomena together even though they cannot all be catalogued as cell secretions. The accent of the chapter is directly on the physiology of the secretion and if occasionally substances which are normally cell bound are included under this head, it is of advantage to notice the analogies of functional condition which may pervade the reactions of the products.

The succeeding chapters from three through twelve deal in the main with individual glands in as complete a manner as is possible in a work of this size. There are excellent bibliographies at the end of each chapter, giving a sequence to the total work performed in organizing the information presented. In Chapter VI, succeeding that treating the pancreas, there is a short and succinct treatment of the alimentary secretions and their relation to the generalized picture of reaction.

Chapter XI is taken up completely with the interaction of the hormones during pregnancy and lactation and an excellent review of what we know about the interacting constituents during these processes.

After a concise treatment of the hypophysis (pituitary) the last 75 pages of text are devoted to a review of endocrine mechanisms in the invertebrates. This is an admirable presentation of the diverse mechanisms and how they work. While one might argue about some of the implied correlations between the activity of vertebrate and invertebrate materials, this in no way detracts from the presentation as a whole. The fact that it is presented in arguable form is a compliment to the ingenuity of the author, for these reacting substances do not have the clarity of result or the known chemistry of the vertebrate secretions.

The book as a whole is informative, carefully prepared, and extremely intriguing. It is a unique treatment of this very interesting field.

J. S. NICHOLAS

Yale University

Pathology. W. A. D. Anderson. (Ed.) St. Louis, Mo.: C. V. Mosby, 1948. Pp. xii + 1453. (Illustrated.) $15.00.

This book is not just another textbook of general pathology. Neither does its virtue lie in any unique manner of presenting its subject, since it follows in general the standardized order, with chapters on the fundamental pathological processes, their variations with etiology, and their manifestations as related to the various parts of the body. The text will have outstanding value for teachers and graduate students of pathology, who will find therein an unusual amount of useful information ordinarily gleaned only by extensive search through periodical literature.

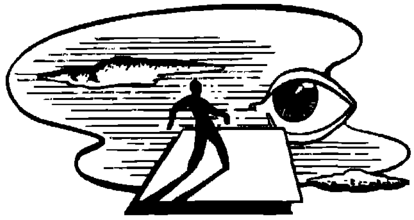
Most of the chapters are written by well-known authorities in the various fields, who have carefully evaluated data from many sources, and have recorded the salient facts in concise, convenient form. The use of headings, spacing, varied printing, and numerous illustrations gives emphasis to the more important subjects and facilitates ready reference. Each chapter is concluded with a generous bibliography, arranged conveniently according to subjects. Most authors have placed commendable emphasis upon relationships between pathology and the other basic sciences, and between pathological changes and clinical phenomena.

The changing order in our modern world justifies the attention directed at the formerly designated "tropical diseases," and to the effects of various forms of radiation upon tissues. Also treated comprehensively are the diseases of the skin, special sense organs, lips, mouth, teeth, and skeletal system. A surprising omission is a chapter on diseases of muscles. This is especially disappointing since a growing interest in this subject is increasing the number of muscle biopsies to be diagnosed by pathologists.

As a textbook, this book will create by its bulk a real problem for medical students who are expected to assimilate it in the usual one-semester course. As a reference book, it can be recommended unreservedly to all who are interested in the problems of disease.

PEARL M. ZEEK

College of Medicine,
University of Cincinnati



Psychiatry in general practice. Melvin W. Thorner. Philadelphia-London: W. B. Saunders, 1948. Pp. xi + 659. $8.00.

The author of this book has attempted to present psychiatry in a language relatively free of confusing terminology, and yet he manages to cover the theories and concepts that are generally accepted today.

The book is divided into two main parts, which are designated as "The People" and "The Methods." In the first part the chapters are named by the principal problem or mental symptom, e.g., "Intelligent People," "Dull People," "People and Sex," "People and Catastrophe," "Unhappy People," "Dreamy People," "Confused People," "Anxious People." One might raise the objection that such titles detract from the dignity of the book. Each chapter has a short informative introduction to the topic, complete illustrative life histories of patients, and an excellent summary. The author hopes to give the student or physician the "feel" of the psychiatric patient and his use of many well-selected case records and brief interpretations of the patients' behavior does much to accomplish this purpose.

Treatment is the theme of the second part of the book. There are good chapters on interviewing, sedation, and psychotherapy. The limitations of such procedures as electroshock therapy and prefrontal lobotomy are discussed. The information about the related shock therapies is concise but adequate to enable the physician to discuss with the family the nature of a treatment that may have been recommended by a psychiatrist or hospital.

This book offers much help to the general practitioner in understanding and treating many of his patients. It is recommended.

FRANK H. LUTON

Vanderbilt University School of Medicine

The aviation psychology program in the Army Air Forces. (Rep. No. 1.) John C. Flanagan. (Ed.) Washington, D. C.: Supt. of Documents, U. S. Govt. Prntng. Office, 1948. Pp. xii + 316. $2.00.

This is the first of a series of 19 volumes designed to record, evaluate, and make available the major research findings and experience of the AAF Psychology Program during the period of World War II. In this volume, Col. Flanagan, who directed the program under the Air Surgeon, Major General David N. W. Grant, and the chief of the Medical Research Division, Col. Loyd E. Griffis, reviews the research findings and discusses their implications. The book is both an introduction and a summary of the series; the titles and editing authors of all 18 volumes of the series are listed on pages 3 and 4. So much credit is given to his military and civilian associates that Col. Flanagan's own outstanding contributions as director and research leader of the program are not immediately evident. The volume is arranged in three parts: I. Background and development of the Aviation Psychology Program; II. Specific solutions of problems; and III. General contributions.

Building on the experience of World War I and on some work accomplished by civilians through the National Research Council and the Civil Aeronautics Administration in 1939 and 1940, the Army program took shape. It was decided to organize a coordinated research program rather than a strongly centralized agency, and to place the work in intimate association with the AAF training fields. Twenty categories were identified by analyzing the reasons for eliminating men from primary flight training. These were grouped into four principal areas for assigning responsibility for test development; (1) tests of information, judgment, and intellectual ability, (2) tests of alertness, observation, and speed of perception, (3) tests of coordination and visual-motor skill, and (4) tests of personality, temperament, and interest. Previous efforts had centered chiefly on selection of pilots. The AAF program envisaged a broader need, that is, the selection and classification of all air-crew.

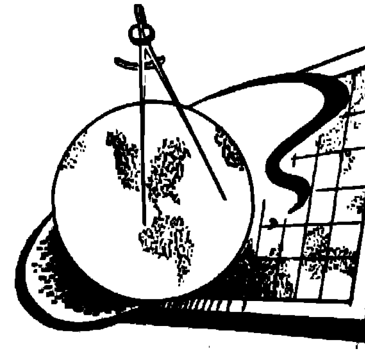
There are five fundamental steps that psychologists use in aptitude testing and personnel selection: I. *Job analysis* of positions for which applicants are to be selected; II. *Test construction* in line with the job analysis by adapting previously used tests or in making up new ones; III. *Test reliability determination* through giving alternate forms to sample populations and noting degree of score agreement; IV. *Rehearsal administration* of proposed tests to training groups otherwise selected for discovering the relation of test scores to success and failure in training; and V. *Validation appraisal* through selecting men for training by the tests developed; then after training or other exhibits of competence in job performance relating the test scores to the success or failure records, and finally discarding those tests which have proved low in prediction value. In the Air Force program several hundred tests were worked through these five steps and only the best twenty or so were used in the final selection batteries. There were two main groups of tests used: (1) The AAF Qualifying Examination (in place of the earlier requirement of two years of college), which was given to more than a million men, and (2) Special Abilities, given to more than a half million in making selections for bombardier, flight engineer, navigator or pilot training.

It is interesting and illustrative of the material presented in Col. Flanagan's Report to note (pp. 82 ff.) that when step IV was applied to more than 1,000 men assigned to pilot preflight schools only 23 percent succeeded in becoming rated pilots, whereas if only the upper half had been admitted, as rated by their scores on the tests being tried out, 75 percent, on the same criteria, would have been rated successful. When the matured selective techniques were used the failure rate dropped so low that fewer training fields were required.

The aviation psychologists were able to develop objective measures of flying skill, aerial measures of navigation proficiency, rating methods for flexible gunnery, and proficiency tests for flight engineers, bombardiers, and radar observers. Their success in screening and selection proved so valuable that they were set to work on the content of training courses and methods of training, and the development of new training devices and equipment. Finally, in the latter part of the war, they initiated a number of testing methods and procedures concerned with individual reactions to combat. As an illustration of the important role that social science can play in human affairs, and of scientific method in social science, this introductory-summary volume and the series of reports it represents may be strongly recommended. Considered from the standpoint of variety of measurements, types of tests, and size of test samples and populations examined, these data from the AAF Psychology Program constitute the largest mass of psychological measurement materials ever gathered in any experimental or applied psychological project. This report and later volumes in the series will long retain their importance in the field of aviation psychology.

W. R. MILES

Yale University



General cartography. (2nd ed.) Erwin Raisz. New York-London: McGraw-Hill, 1948. Pp. xv + 354. (Illustrated.) $6.00.

General cartography is a thoroughly revised edition of the book which appeared a decade ago under the same title. It contains a wealth of valuable information and will become one of the indispensable reference books of the cartographer's library.

The quickest way to obtain an idea of the scope of the book is to examine its table of contents: I—The History of Maps, II—Scales and Projections, III—Representation of the Earth's Pattern on Maps, IV—Lettering, Composition and Drafting of Maps, V—Surveying on the ground and from the air, VI—Official and Professional Maps, VII—Cartographic Specialities, VIII—Scientific Maps.

Each of the eight parts listed is composed of four chapters, making 32 in all. This division of the text makes the volume readily adaptable to use in a majority of college courses. There is also an appendix offering instructions for preserving and cataloguing maps, laboratory and field exercises for student assignment, a series of useful tables, and a bibliography of easily available references.

General cartography holds the distinction of being the only book covering the field of modern cartography by an American author. It is up to date, well illustrated, and authoritative. The task of gathering and assembling the material for this volume obviously has required many years of careful research. The finished work is a credit to the author.

As might be expected in view of Dr. Raisz's extensive study of the history of maps, the book contains an excellent treatment of early map making. With the aid of four fully annotated time charts, the author traces the history of cartography from 600 B. C. down to the present. The reader will find descriptions and illustrations of the charts of the Marshall Islanders, the clay tablet maps of the Babylonians, and the early maps of the Greek, Egyptian, Chinese, and Roman cartographers, including the Ptolemy maps and portolan charts. The achievements of the Dutch, French, German, English and Italian cartographers, the work of the National Surveys, and the growth of American cartography are all fully reported. The four chapters dealing with the history of maps are valuable reading for all cartographers.

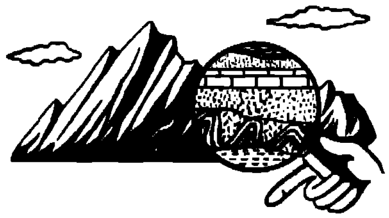
The main body of the text is devoted to methods and techniques employed in modern cartography. Unfortunately the author has attempted to cover everything and consequently has failed to give adequate attention to many of the basic elements of the subject. This situation is understandable when one realizes the magnitude of the assignment but it is nevertheless regrettable. Important topics such as relief presentation, map composition, map reproduction, and projections are treated briefly. In the opinion of the reviewer the book would serve more effectively as a text if it gave more attention to how to plan and execute cartographic jobs and less attention to what has been done in the field and by whom. Every page contains interesting and useful information, but much of this is not directly applicable to teaching the subject.

No review of Dr. Raisz's latest book would be complete without mention of the chapters dealing with the application of cartographic and related techniques to the presentation of statistical information. Many excellent methods of putting life into inert masses of figures have been described and illustrated. Statisticians, economists, and geographers will do well to study those chapters carefully.

General cartography is the work of a scientist and artist. It is a contribution to the subject of cartography and will play an important role in the development of the science.

WALLACE W. ATWOOD, JR.

Research and Development Board



Sedimentary rocks. F. J. Pettijohn. New York: Harper, 1949. Pp. xv + 526. (Illustrated.) $7.50.

Sedimentary rocks, by F. J. Pettijohn, comes at an opportune time, 10 years after the last comprehensive volume on sedimentation was published by Twenhofel. Pettijohn's treatise is essentially a study of the products of sedimentation rather than its processes. The book begins by summarizing the general nature of sedimentary rocks and discussing their principal attributes: texture, mineral and chemical composition, structure, and color. A chapter on classification follows, and then the principal types of sedimentary rocks are described in considerable detail. The work concludes with a discussion of the processes of weathering, transportation, deposition, and diagenesis.

The general approach is well balanced and attention is focused on the more important aspects of sedimentation. Minor controversial features are dismissed with brief discussions or reference to pertinent literature. The 700 citations to previous literature are well chosen and up to date. Pettijohn's general appraisal of other authors' work is good, but he places more reliance on the validity of some inferences he cites than this reviewer would. The volume contains many tables on the chemical and mineralogical composition of sedimentary rocks. The illustrations are well chosen and include many graphs showing quantitative relationships of properties of sediments to one another. The index is moderately good.

This book is so worthwhile that any attempt to point out its weak parts is likely to overemphasize them with respect to the work as a whole. The discussion of black shale, ocean and lacustrine deposits, and the fundamental physical and chemical processes affecting sediments seems to be less effectively treated than other subjects; but on the other hand the discussion of glacial sediments, abrasion of particles, quantitative aspects of sedimentation, and applications of laboratory studies to the interpretation of sediments is extremely stimulating. The section on geosynclinal sedimentation is particularly interesting.

Pettijohn has proposed a new classification of sedimentary rocks, partly descriptive and partly genetic. Geologists may have mixed feeling over some of the names that are recommended. For example, to call a quartzose sandstone an "orthoquartzite" is likely to cause confusion, because of the well-established usage of the term "quartzite" in metamorphic geology. On the other hand, the designation of the term "graywacke" for an indurated feldspathic sand with a clay or chlorite matrix seems quite useful.

This volume, according to the author, is designed as a text for senior and graduate students. It is also a handy book for the mature worker and altogether represents a distinct contribution to geology.

PARKER D. TRASK

Oakland, California

Geology and paleontology. (Fiat Review of German Science, 1939–1946.) Ludwig Rüger, et al. Berlin: Office of Military Government for Germany, 1948. Pp. 246. (Illustrated.)

This volume is one of a series which, in the words of its sponsors, is intended to "present a complete and concise account of the investigations and advances of a fundamental scientific nature made by German scientists in the fields of biology, chemistry, mathematics, medicine, physics and sciences of the earth during the period May 1939 to May 1946." The series will include reviews of work on 44 subjects within these fields; some subjects, such as inorganic chemistry and applied mathematics, require five or six volumes.

Besides the present volume, the earth sciences are represented in the series by four volumes devoted to geography, one to mineralogy, and two to petrography.

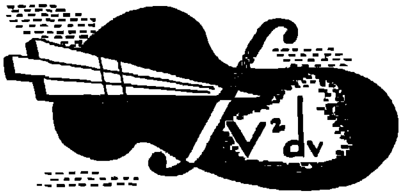
The following have contributed reviews to Part I of the work (general geology): L. Rüger (geologic chronology; interior of the earth, vulcanism); D. Schachner-Korn (structural geology); K. H. Scheumann (petrotectonics of the Variscan and pre-Variscan crystallines on the northern border of the Bohemian Massif and in the Sudeten); A. Strigel (tectogenesis of the European and North African Variscan [Hercynian]); W. Carle (post-Variscan tectonics in central Europe); A. Bentz (salt domes, petroleum geology); W. Schött (recent deep-sea sediments); E. Stach (coal petrography); E. Blanck (weathering); and H. E. Stremme (soil science).

To Part II (formations) the following contributed: M. Schwarzbach (Cambrian); G. Sollo (Devonian); A. Strigel (Carboniferous, Permian); W. Schott (Triassic, Weissjura); K. Hoffmann (Lias and Dogger); O. Seitz (Cretaceous); A. Schad (Tertiary of northwest Germany); E. Wirth (Tertiary of the upper Rhine Valley); and E. Ebers (Quaternary geology of the Northern Alps).

The third and last section, paleontology, is constituted as follows: H. Hiltermann (micropaleontology); M.

those explaining the irregularities in physiology and nutrition of animals and man.

E. R. Graham and Wm. A. Albrecht
University of Missouri



Rings and ideals. Neal H. McCoy. (Carus Mathematical Monographs of The Mathematical Association of America.) LaSalle, Ill.: Open Court Publ., 1948. Pp. xii + 216. $2.00.

This attractive little volume, well written and neatly printed, offers an excellent and almost entirely self-contained introduction to some of the most interesting topics in elementary modern algebra. Chapter I discusses the idea of a ring, with the help of some carefully thought out examples; chapter II further illustrates the same concept by a more detailed discussion of polynomial rings. Chapter III introduces the all-important notions of the ideal, of homomorphism, and of the residue class ring. After some auxiliary results in chapter IV, chapters V and VI offer an excellent, thoroughly modern, and lucid treatment, by means of Zorn's principle (without any finiteness assumptions), of the basic properties of the radical and of the Jacobson radical, and their application to the representation of rings as direct or subdirect sums. This is illustrated, in chapter VII, by a discussion of Boolean rings and of p-rings. The last two chapters (somewhat loosely connected with the rest of the book) give a concise exposition of matrices and determinants over arbitrary commutative rings (knowledge of the theory of determinants over a field being assumed), and of the basic facts concerning primary ideals and Noetherian rings.

Utmost simplicity has been reached in nearly all proofs; this, together with an easy and readable style, and a skillful use of examples, should put the book well within reach of beginners in the field, without rigor being sacrificed in any way to this object. Both the simplicity of the exposition and the generality of the results are further enhanced by the fact that the author carefully avoids bringing in any assumption before it really becomes necessary; when he does so, he takes into account the results of the latest research, including some of his own. Thus, chain-conditions are not even mentioned before the last chapter. Similarly, commutativity is introduced only when it is needed, even though the emphasis is mostly on commutative problems and methods. All this is in full agreement with the lastest developments in algebraic theory and practice, and should prove most helpful to readers who wish to acquaint themselves with such developments; further help and guidance is provided by means of a good bibliography and a brief discussion of the main source material at the end of each chapter.

The author deserves to be congratulated for this valuable addition to the literature; and the book may be warmly commended, both to newcomers to the subject and to those who have lost contact with it and may wish to bring their knowledge of its basic principles up to date.

André Weil
University of Chicago

Introduction to applied mathematics. Francis D. Murnaghan. New York: John Wiley; London: Chapman & Hall, 1948. Pp. ix + 389. $5.00.

This is a time when applied mathematics is being cultivated very vigorously. Problems of gas dynamics, elasticity, atomic physics, and nonlinear mechanics, to name but a few fields, require the most powerful and advanced tools available to the mathematician, physicist, or engineer. Coincidentally, there is a need for books which will present in a clear, connected, and reasonably complete fashion the known facts about eigenvalue problems, partial differential equations, integral equations, calculus of variations, etc. Prof. Murnaghan, who has done outstanding work in applied mathematics, has drawn on his twenty years' experience in presenting such material to graduate students and has written a good and helpful introduction to the field.

The first two chapters are devoted to vectors and matrices. The treatment is vigorous and proceeds from the special to the general, a plan followed wherever possible throughout the book. Included are n-dimensional complex space and an introduction to the eigenvalue problem. Chapter 3, one of the most important, carries the discussion into function space; here the student will find orthonormal sets of functions, generalized Fourier expansions, and linear integral operators. Chapters 4 and 5 discuss curvilinear coordinates and Laplace's equation. Considerable attention is paid in the latter chapter to the useful "method of images." Chapter 6 discusses separation of variables for partial differential equations, power-series methods for ordinary differential equations, and special functions. In Chapter 7, the student will find self-adjoint linear differential operators, boundary conditions of various types, and a very complete discussion of Green's functions—including the central theorem concerning the equivalence of linear second-order boundary-value problems and Fredholm integral equations. Chapter 8 gives the theory of Fredholm integral equations and concludes with a careful discussion of Rayleigh's principle. Chapter 9 discusses the calculus of variations, with applications to dynamics. The last chapter is devoted to operational calculus, based on the unilateral Laplace transformation. The discussion is restricted to ordinary differential equations of general order and systems of such, but these are treated completely.

Altogether, the reviewer considers this a good though demanding introduction to applied mathematics. The word *introduction* is to be emphasized; in its 389 pages, the author has been forced to omit mention of several important topics, notably initial value problems. However, there are good discussions elsewhere of most of the omitted questions—while of the topics included, there are several for which no careful treatment at the beginning graduate level has been available previously. The typography is excellent (boldface and italics are used freely), and there are numerous exercises, many of which serve to amplify and extend the text. All through the book there are informal notes, cautions, and pointed queries, which serve the double purpose of easing the sometimes heavy going and of keeping the reader alert.

A. Weinstein

U. S. Naval Ordnance Laboratory

Functional analysis and semi-groups. Einar Hille. (American Mathematical Society Colloquium Publications, Vol. XXXI.) New York: American Mathematical Soc., 1948. Pp. xi + 528. $7.50.

A semigroup is an associative (but not necessarily commutative) multiplicative system. It is more general than a group because neither the existence of the unit element (and *a fortiori* of the inverse element) nor the rule of cancellation (rule of division) is assumed. This book is devoted to the study of such systems and their representation by linear operators in a Hilbert or a Banach space (for example, a one-parameter semigroup of operators T_t, $t > 0$, which satisfy $T_s T_t = T_{s+t}$ for any positive s and t).

Investigation of semigroups and their representations is not only interesting as a mathematical theory by itself (Laplace transforms and binomial series, Fourier series and integrals, summability and Tauberian theorems, operator calculus and spectral theory), but it is also important in view of its application to probability and statistical mechanics where the notion of irreversibility and tendency toward equilibrium comes into question (ergodic theory, Markoff processes, stochastic processes, diffusion problem, conduction of heat, and related partial differential equations).

The book consists of three parts and an appendix. The first part, which is a preparation for the rest of the book, is itself a self-contained, up-to-date introduction to the theory of functional spaces. Part II develops an analytical theory of general semigroups and their representations, which is applied in Part III to special cases to obtain important results concerning groups and their representations in a unified way. The book also contains many interesting results of the author which have not been published elsewhere.

The appendix is an exposition of the theory of Banach algebras (normed rings), a field which promises to become one of the main centers of mathematical interest. Here the stress is shifted to the algebraical aspects of the problem, while in the main body of the book emphasis is always placed on the analysis. Readers who have witnessed the achievements of topological and operational methods in functional analysis (differential and integral equations, theory of Hilbert and Banach spaces) will find the recent success of the algebraic method (as in the case of Tauberian theorems) very interesting. Professor Hille's book constitutes an important addition to mathematical literature, coming as it does at a moment when systematic rearrangement and clear exposition of the various results of this already large and ever-growing subject seem to be necessary for the purpose of stimulating further progress in research.

Shizuo Kakutani

Institute for Advanced Study

Theory of equations. J. V. Uspensky. New York-London: McGraw-Hill, 1948. Pp. vii + 353. $4.50.

The late Prof. Uspensky's new volume will be welcomed by all who teach or use the theory of equations. It is considerably longer than the well-known texts of Profs. Dickson, Weisner, and J. M. Thomas, and presents a wealth of ideas in easily available form.

The discussion of the numerical solution of real polynomial equations is masterly, and includes valuable appendices on Routh's rule, iterative methods, Graeffe's method, and a new method for separating roots (Vincent's method). This discussion will make the book a valuable text and reference book for engineers.

On the other hand, no flavor of the modern abstract point of view is given: thus "fields" of complex numbers are nowhere defined, and matrices are treated after determinants. Moreover, the classical prescription offered for solving simultaneous linear equations by Cramer's Rule (determinants), however elegant theoretically, is notoriously ineffective. For these reasons, many teachers will wish to use the book not as a basic text but as a supplementary text or reference. It should be nearly indispensable for that purpose.

Garrett Birkhoff

Harvard University

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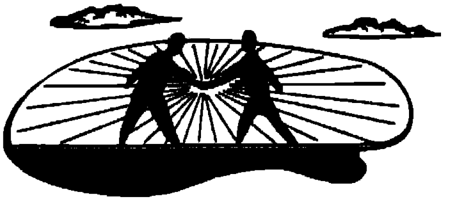

Association Affairs

The Southwestern Division of the AAAS will hold its 25th meeting in Alpine, Texas on May 1–5, under the presidency of R. A. Studhalter, of the Department of Biology of the Texas Technological College. Host institutions are the Sul Ross State Teachers College and the McDonald Observatory on Mt. Locke near Ft. Davis. Alpine, a frontier town of 6,000 population, is the home of Sul Ross State College. It is located on the Southern Pacific and Santa Fe Railroads at an altitude of approximately 4,500 feet. Highway 90 leads through Alpine from San Antonio to El Paso; highway 118 joins Alpine and Ft. Davis. The general area is that of the cattle kingdom of Texas.

McDonald Observatory, a branch of the Yerkes Observatory, is operated jointly by the University of Chicago and the University of Texas. It is located 15 miles northwest of Ft. Davis on a paved highway. Ft. Davis was established as a frontier outpost prior to the Civil War, and was abandoned as a military post when the Davis Mountain area no longer held a threat of Indian attack. Ruins of the old fort, some now in process of reconstruction, are of considerable interest.

Ojinaga, Mexico, just across the Rio Grande from Presidio, Texas, will be the destination of an excursion on Tuesday afternoon and evening. Ojinaga is a typical Mexican town and entirely representative of the rural areas of Old Mexico.

The annual Powell Lecture is to be delivered by John Charles Kelley, assistant professor and curator of anthropology at the University of Texas Museum. He is regarded as an authority on the archaeology of the Texas Indians. The general program will be enriched by the participation of a number of Mexican and Texan organizations, including the Sociedad Chihuahuense de Estudios Históricos, the Texas Academy of Science, the Texas Archaeological and Paleontological Society, and the West Texas Historical and Scientific Society.

The section meetings will close on Wednesday and there will be an all-day excursion to the Big Bend National Park on Thursday. The local group, under the chairmanship of G. Preston Smith, dean of the Sul Ross State College, has spared no effort to make the meeting a great success. It is hoped that the attendance will be large, in order to assure the local host institutions that their efforts have not been wasted.

Frank E. E. Germann

General Program

Sunday, May 1, 1949. *3 : 00 p.m.*: Meeting of the executive committee, Southwest Division, Room 217, Main Building, Sul Ross College. *8 : 00 p.m.*: Open House, McDonald Observatory.

Monday, May 2, 1949. *8 : 30–9 : 45 a.m.*: **Registration, Library Building, Sul Ross College. Registration continues** through Wednesday. *10 : 00–12 : 00 a.m.*: General Session, Sul Ross Auditorium. Music—Glenn Davis, head of the Music Department, Sul Ross State College, directing. Address of welcome—R. M. Hawkins, president, Sul Ross State College. Response—R. A. Studhalter, president of Southwestern Division. Address—Gerard P. Kuiper, director of Yerkes and McDonald Observatories. *1 : 30–3 : 30 p.m.*: Section meetings. *3 : 45–5 : 00 p.m.*: "Ten Years of Astronomical Observation at McDonald Observatory," Gerard P. Kuiper, Sul Ross Auditorium. *5 : 00–6 : 00 p.m.*: Open House, Museum of West Texas Historical and Scientific Society. *8 : 00 p.m.*: John Wesley Powell Lecture, John Charles Kelley, assistant professor of anthropology and curator of the Anthropology Museum, University of Texas, Auditorium, Sul Ross College. (The public is cordially invited.)

Tuesday, May 3, 1949. *7 : 30 a.m.*: Breakfast, Sigma Xi. Place to be announced. *8 : 30–10 : 00 a.m.*: Section meetings. *10 : 00–12 : 00 a.m.*: Report from McDonald Observatory, Sul Ross Auditorium. *1 : 00 p.m.*: Luncheon, complimenting visiting ladies, Indian Lodge. *1 : 00–3 : 30 p.m.*: Meeting of the Texas Archaeological and Paleontological Society, Col. M. L. Crimmins, U. S. Army, retired, presiding, at the Auditorium, Education Building. *3 : 30–10 : 30 p.m.*: Tour to Ojinaga, Mexico, including dinner, Roof Garden, Rohana Hotel, Ojinaga.

Wednesday, May 4, 1949. *7 : 30 a.m.*: Breakfast, Phi Delta Kappa. Place to be announced. *8 : 30–11 : 00 a.m.*: Meeting of the Texas Academy of Science, Sul Ross Auditorium. C. M. Pomerat, professor of cytology, Medical Branch, University of Texas, Galveston, Texas, presiding. *11 : 10–12 : 00 a.m.*: Address by President J. Brian Eby of the Academy, "Geophysics and Geology in Oil Exploration," Sul Ross Auditorium. *1 : 30–3 : 00 p.m.*: Section meetings. *3 : 00–4 : 00 p.m.*: Movie film (partly kodachrome) taken during World War II in Nigeria and the African Gold Coast of leper colonies, market places, disk-lip people of the interior, a boat trip on Lake Alo (part of old Lake Tchad), a boat trip on the Volta River, etc. A 40-minute film preceded by a 20-minute introduction. Albert R. Mead, University of Arizona, Tucson. Sul Ross Auditorium. *4 : 00–5 : 00 p.m.*: Business session and election of officers. Sul Ross Auditorium. *6 : 00 p.m.*: Open air barbecue, complimenting members of the Southwestern Division and cooperating organizations, Kokernot Lodge. *8 : 00 p.m.*: Address of R. A. Studhalter, retiring president, Sul Ross Auditorium.

Thursday, May 5, 1949. *8 : 00 a.m.*: All-day field trip to Big Bend Park, including St. Helena canyon. The noon meal will be served at the Park.

NEWS and Notes

Frederick W. Heimberger, Ohio State University faculty member since 1936, has been appointed dean of the College of Arts and Sciences, effective April 15. Dr. Heimberger has served as acting dean since October 1948, when **Dean Harlan H. Hatcher** was made vice president of the University.

Leonard E. Johnston, manager of the Atomic Energy Commission's Knolls Atomic Power Laboratory in Schenectady, New York, has been appointed manager of the AEC's new national nuclear reactor testing station, to be built near Arco, Idaho. Until a successor is appointed at Schenectady, Mr. Johnston will act as manager of both the laboratory and the testing station.

The Howard Crosby Warren Medal has been awarded to **Walter R. Miles**, professor of psychology, Yale University, by the Society for Experimental Psychology, in recognition of his work on night vision during the war.

W. T. Edmondson has resigned as lecturer on biology at Harvard University to accept appointment as assistant professor of zoology at the University of Washington, Seattle, where he will take charge of the program in limnology and ecology.

Alfonso Draghetti, director of the Agriculture Experiment Station at Modena, Italy, has been appointed director of the Experiment Station for Sugar Beet Culture, at Rovigo, Italy. He succeeds Ottavio Munerati.

George R. Herrmann, University of Texas, has been admitted to the Academia Nacional de Medicina of Venezuela.

Sol Pincus, member of the Board of Consultants on Sanitation and Food Problems of the U. S. Public Health Service, has left for Geneva, Switzerland, where he will set up a section on Environmental Sanitation for the World Health Organization.

Lindsay S. Olive, professor of botany, Louisiana State University, has been appointed associate professor of botany at Columbia University, where he will be in charge of graduate instruction in mycology, beginning in September.

Visitors to U. S.

Hasib Kurtpinar, chief of the parasitology section of the Turkish Ministry of Agriculture, has been in this country for more than two years, making a study of recent developments in parasitology. He is now a guest of the Beltsville (Maryland) laboratories of the Bureau of Animal Industry's Zoological Division. Before sailing for Turkey in September, Dr. Kurtpinar expects to visit the Zoological Division's station at Albuquerque, New Mexico, the Bureau of Entomology and Plant Quarantine's station at Kerrville, Texas, and the Veterinary School of Colorado State College.

Gunnar Thorson, of the University of Copenhagen, has joined the staff of the University of California's Scripps Institution of Oceanography as a visiting professor of zoology. He plans to stay in this country three or four months to continue his study of the larvae of marine animals.

Gordon Brims Black McIvor Sutherland, Cambridge University spectroscopist, has been named professor of physics at the University of Michigan.

Grants and Awards

The Columbia University Engineering School Alumni Association will present its 1949 **Egleston Medal** for distinguished engineering achievement to Harvey S. Mudd, president and managing director of Cyprus Mines Corporation. The award will be made April 28 at the Columbia University Club, New York City.

The University of Wisconsin has received a gift of $10,300 from the Thomas E. Brittingham trust fund to initiate an intensive study of arthritis and rheumatism. D. M. Angevine and C. H. Altshuler, Department of Pathology; Harry Bauman, Department of Physical Medicine; and C. V. Seastone, Department of Microbiology, will be in charge of the research.

Cornell University announces the following awards to members of its faculty: to Arthur A. Allen, the **Burr Prize** of the National Geographic Society, for work done in ornithology; and to George Winter, the first **Moisseiff Award** of the American Society of Civil Engineers.

The Rockefeller Foundation has awarded $25,000 to Princeton University for basic research in psychology, to be conducted by Hadley Cantril, Department of Psychology, in collaboration with Adelbert Ames, Jr., Hanover Institute, Hanover, New Hampshire.

Herman L. Kretschmer, president of the Institute of Medicine of Chicago, was recently awarded the **Cross of the Chevalier of the Legion of Honor of France** for his scientific achievements in the field of medicine and medical education.

W. J. Dakin, formerly professor of zoology at the University of Sydney, was chosen **Mueller Medallist** at the 27th conference of the Australian and New Zealand Association for the Advancement of Science, recently held in Tasmania.

The Canadian Council for Reconstruction, through Unesco, has granted $15,000 to the Pasteur Institute in Paris. The agency has also sent scientific equipment worth $60,000 to university laboratories in Belgium, Austria, France, Norway, the Philippines, Greece, and Italy, and has offered free subscriptions to scientific journals to 92 universities.

The American College of Physicians made the following awards at its annual convocation, held in New York City, March 30: **The John Phillips Memorial Award**, to Edwin B. Astwood, research professor of medicine, Tufts College Medical School, for achievement in internal medicine; **The Alfred Stengel Memorial Award**, to James J. Waring, professor of medicine, University of Colorado School of Medicine, for influence in the advancement of medical education, practice, and research; **The James D. Bruce Memorial Award**, to Stanhope Bayne-Jones, president of the Joint Administration Board of the New York Hospital-Cornell Medical Center, for achievement in preventive medicine. The following doctors were made **Masters of the American College of Physicians** at the same meeting: James J. Waring; Elliott P. Joslin, clinical professor emeritus of medicine, Harvard Medical School; Jonathan C. Meakins, professor emeritus of Medicine, and dean emeritus of the medical faculty, McGill University; and Virgil P. Sydenstricker, professor of medicine, University of Georgia School of Medicine.

Fellowships

Vassar College invites applications for the $1,500 **Helen Gates Putnam Graduate Fellowship in Conservation** for 1949–50. Work may be carried on in any field of plant science related to conservation, and will lead to an M.S. degree in plant science. Applications should be sent to Gladys E. Baker, Chairman, Plant Science Department, Vassar College, Poughkeepsie, New York.

The Arctic Institute of North America is offering a number of grants-in-aid for specific programs of scientific research in the North American Arctic and Subarctic during 1950. Research must include field investigations in Alaska, northern Canada, Labrador, Newfoundland, or Greenland. Application forms may be obtained by writing to The Arctic Institute of North America, 3485 University Street, Montreal, Canada or Audubon Terrace, Broadway and 156th Street, New York City 32. Applications must be in by *November 1.*

The American Cancer Society announces the availability of the **Damon Runyon Clinical Research Fellowships** which it administers upon recommendation of the NRC. Open to men and women with the M.D. degree, the fellowships will, in most cases, provide a period of training in a hospital under the guidance of a qualified clinical investigator but may also be awarded for training in a basic science provided that such training is directed toward preparing the fellow for clinical cancer research. The annual stipend may vary from $2,500 to $6,000; in most instances it will not exceed $4,000. Applications may be submitted at any time and should be addressed to the Executive Secretary, Committee on Growth, National Research Council, 2101 Constitution Avenue, Washington 25, D. C.

Colleges and Universities

The Medical School of the University of Chile, Santiago, which was destroyed by fire last December, appeals to American scientists to send reprints and books on cytology, genetics, and experimental cancer to Dr. Gabriel Gasic, Casilla 2988, Santiago, Chile.

Northwestern University's Medical School has established a radioisotope unit, equipped by a grant from the Atomic Energy Commission through the Office of Naval Research, for instruction, research, and therapy. Howard L. Alt, associate professor of medicine, is chairman of the unit.

Harvard University plans to establish a Laboratory of Human Development for the study of children's behavior. Robert Sears, professor of education and child psychology, has been appointed director and he will be assisted by John W. M. Whiting and Pauline S. Sears. As a preliminary step toward helping schools to understand their pupils, the laboratory will first study the early childhood origins of social motives—the drives to dependency, aggression, and competition that set the patterns of living.

Meetings and Elections

The Cancer Teaching Program of the University of Utah College of Medicine, and the Bureau of Cancer Control of the State Department of Health, will present the **Second Annual Cancer Symposium** April 25–27. Guest speakers will include: George T. Pack, clinical professor of Surgery, New York Medical College; Charles E. McLennan, professor and head of the Department of Obstetrics and Gynecology, Stanford University College of Medicine; Henry S. Kaplan, professor and head of the Department of Radiology, Stanford University College of Medicine; Rulon W. Rawson, chief, Department of Clinical Investigation, Sloan-Kettering Institute of Cancer Research and associate professor of Medicine, Cornell University Medical College; and Howard L. Richardson, assistant professor of Pathology, University of Oregon Medical School.

The West Virginia Academy of Science will hold its 24th annual meeting at Davis and Elkins College, Elkins, West Virginia, April 29–30. Nelle Ammons, of West Virginia University, will give the presidential address, on "The Responsibility of an Academy of Science." Laurence H. Snyder, dean of the Graduate School, University of Oklahoma, will speak on "Heredity and Modern Life."

The American Mathematical Society will hold its 447th meeting at the University of Kansas, in Lawrence, April 29–30. E. J. Mickle, Ohio State University, will speak on "Some Properties of the Lebesgue Area," and R. M. Thrall, University of Michigan, on "Classes of Algebras with Radical." A. S. Householder, Oak Ridge National Laboratory, will address a joint session of the AMS and the **Biometric Society** on "Diffusion of Isotopes in Biological Systems of Several Compartments," John Wishart, of Cambridge University and the University of North Carolina, on "The Elementary Tests of Significance," and J. W. Tukey, Princeton University, on "The Consultant and the Biologist."

The Kentucky Academy of Science will hold its annual meeting at Cumberland Falls State Park, Kentucky, April 29–30. The meeting will include a symposium and field trip on stream life.

The Illinois State Academy of Science will meet May 6–7 at Knox College, Galesburg. The theme of the program is "Science Education." Willard B. Spalding, dean of the College of Education, University of Illinois, and C. W. Sanford, director of the Illinois Secondary School Curriculum program will speak at general sessions. There will be an education panel discussion in the Psychology and Education Section. R. F. Paton, president of the Academy, will speak at the general session on "Available Energy."

Seventy women engineering students from eastern colleges met recently at Drexel Institute of Technology in Philadelphia to form a **Society of Women Engineers.** Phyllis Evans, a junior at Drexel, was elected president; Margaret Bliss, Tufts, vice president; and Joyce Killian, Alfred University, treasurer.

The Second National Conference of the U. S. National Commission for Unesco was held at Cleveland, Ohio March 31–April 2, following a two-day meeting of the Commission.

Registration was about 3,000 and attendance at the public meeting on the evening of April 1 exceeded 9,000. Although it was designated a national conference, 28 foreign countries were represented. Jaime Torres Bodet, Director General of Unesco, gave one of the principal addresses, and Milton S. Eisenhower, Chairman of the U. S. National Commission, presided at the general sessions. Speakers included Sir John Maud, Permanent Secretary, Ministry of Education, United Kingdom; Sir Ramaswami Mudaliar, Prime Minister of Mysore, India; George V. Allen, Assistant Secretary of State for Public Affairs; and Mrs. Franklin D. Roosevelt, who discussed the development of the Universal Declaration of Human Rights.

Representatives at the conference were from educational organizations ranging from kindergartens to professional schools and learned societies; from general organizations, such as churches, the Farm Bureau, and the Y. M. C. A.; from business organizations, including chambers of commerce, and motion picture, publishing, and broadcasting firms; and from government, principally the Department of State. The conference program provided for such diverse backgrounds by offering simultaneous group and section meetings alternately with the general plenary sessions.

An excellent exhibit of Unesco activities had been prepared and related motion pictures were shown daily. Three 40-page editions of a conference *Journal*, presenting digests of the principal addresses, summaries of group meetings, and general news of the proceedings, gave representatives an opportunity to discuss with others in attendance the events of the conference.

It is difficult to appraise the conference. The diverse interests of the participants and the necessarily intangible character of many of the addresses gave an impression of indefiniteness. Perhaps this was desirable, as well as unavoidable, because many representatives might have lost interest in more specific discussions. However, the general aims and accomplishments of Unesco were well presented, and delegates were given inspiration, to carry back to their own organizations and communities, toward the furtherance of international peace.

DONALD B. PRENTICE

Deaths

Benjamin H. Grave, 71, embryologist for many years, at the Marine Biological Laboratory, Woods Hole, Massachusetts, died January 24, following a fall which fractured his hip.

Max M. Peet, 63, head of the neurosurgery department of the University of Michigan School of Medicine, died March 25 of a heart attack. Dr. Peet was internationally known for his development of an operation for removal of the splanchnic nerves to relieve high blood pressure.

Friedrich Bergius, 64, German chemist who won the 1931 Nobel Prize for developing a process to produce gasoline from coal, died March 30 in Buenos Aires.

William B. Bell, 71, retired chief of the Wildlife Research Division of the Fish and Wildlife Service, in which he served for 28 years, died March 31 at his home in Washington, D. C.

Augustus Daniel Imms, 68, British entomologist, died April 3, at his home near Sidmouth, Devon. Dr. Imms was reader in entomology at Cambridge University from 1931 until his retirement in 1946, and during that period was president of the Royal Entomological Society of London and the Association of Economic Biologists.

A handbook of biological and medical data is being planned by the American Institute of Biological Sciences, with support from the Aero Medical Laboratory, Air Materiel Command, and the School of Aviation Medicine, Randolph Air Force Base. It will present, in the condensed form used by handbooks of chemistry and physics, data from many fields of fundamental and applied biology. The project will be a continuing one, with revised and enlarged editions following the initial volume at regular intervals. All interested biologists are urged to send suggestions on what material should be included and where it can be found to: American Institute of Biological Sciences, 2101 Constitution Avenue, Washington 25, D. C.

The new Aerobiology Department at the Randolph Field School of Aviation Medicine, under the direction of Roland B. Mitchell, is studying the effects of varying environmental factors on infection and immunity. Specifically, the problem is to determine what a given infection, particularly a pulmonary infection, will do to its victim under conditions of rapid change from ground level to extremely high altitude. A preliminary report states that "on experimental pneumococcal, it appeared that animals given a certain dose and then placed at altitudes of 20,000 feet seemed to develop a more rapid and lethal pneumonia than animals given the same dose but maintained at ground level."

Make Plans for—

American Geophysical Union, 24th regional meeting in conjunction with the Western Snow Conference, April 26–27, Denver, Colorado.

Midwestern Psychological Association, April 29–30, Drake Hotel, Chicago.

The National Academy of Sciences:

Abstracts of Papers Presented at the 1949 Annual Meeting

The Future of the Quantum Mechanical Theory of Chemical Binding

Robert S. Mulliken, *University of Chicago*

Not long after its inception in 1925–6, quantum mechanics gave the first real qualitative and roughly quantitative explanation of the formation of molecules of the covalent type. In the period 1927–35 many of the most able theoretical physicists and chemical physicists explored the possibilities of a really accurate quantitative understanding of molecular forces and energies by the use of quantum mechanics. While the reliability of this theory as a basis for handling such problems was established without question, its practical application for accurate computations was found to be beset with mathematical complexities. As a result of this situation and of the wartime focusing of efforts on problems of nuclear energy and nuclear structure, the further development of this important and potentially very rich field has been grossly neglected, especially in this country. But in spite of the discouragements hitherto encountered in attempts at quantitative accuracy, the writer is optimistic as to the future possibilities for at least moderate success in this field; though probably only by a more patient, more systematic, and more comprehensive program of study than that of the pioneers. Some results which may be a step in the direction of such a program were outlined at the meeting.

Detection and Measurement of the Size of Aerosol Particles in the Range below Tyndall Beam Detection

Victor K. LaMer, Irwin B. Wilson, and Edward C. Y. Inn[*]
Columbia University

The intensity of the light scattered by a small aerosol particle decreases as the inverse sixth power of the radius. Accordingly, the practical lower limit of detection is about 0.03 μ and of measurement by direct optical means is about 0.1 μ. Aerosols of smaller (uniform) size are prepared by heating 99% H_2SO_4 in the LaMer-Sinclair homogeneous generator. No Tyndall beam can be detected. The particles are then grown by a factor of 2- to 10-fold in radius, corresponding to 8- to 1000-fold in volume, or 64- to 10^6-fold in light scattering power, by passage over a solution of H_2SO_4 of known water content. Aqueous tension equilibrium is established promptly and the particle grows to a size fixed by the H_2SO_4–H_2O composition of the master solution.

The number and radii of the grown particles are then determined by the rapid optical methods described previously (see *J. Colloid Sci.*); the size of the original nondetectable particles is then easily calculable from the known absorption of water vapor.

Composition of Meteoritic Matter, Nuclear Shell Structure, and the Principle of Regularity and Continuity of Series

William D. Harkins, *University of Chicago*

In 1917 the following principle was introduced into nuclear science (W. D. Harkins, *J. Am. chem. Soc. 39*, 856): the abundance of elements (nuclear species also—1921) is determined by their nuclear relations. Among these, nuclear stability is fundamentally important. However, since in most nuclear reactions (aside from fission) at energies less than 50–100 Mev only neighboring atomic species are involved, the origin of nuclei and their growth by nuclear reactions determine what nuclei are formed.

It was assumed that the very lightest atoms are formed from hydrogen (protons) but heavier atoms from neutrons. The first important relation to be discovered was predicted by a theory of the writer: in the meteorites elements of even atomic or proton number are much more abundant than those of odd number, and also each even element is more abundant than either of the two adjacent odd elements.

An even more striking fact is that *very few atoms* are stable if *N* is odd, and none *with both* N *and* P *odd*, unless $N = P$.

TABLE 1

Class (N = neutrons ; P = protons)				Abundance in atomic percentage	
				Earth's crust	Meteorites
Class I	N—even		P—even	87.4	95.4
Class II	N—even		P—odd	10.8	2.1
Class III	N—odd		P—even	1.8	2.5
Class IVa	N—odd	>	P—odd	0.0	0.0
b	N—odd	=	P—odd		
			(Heavy hydrogen, Li^6, B^{10} and N^{14})*		

* Nitrogen, N^{14} (7 neutrons, 7 protons) is the only species of Class IV which is abundant (in the stars).

The isotopic number $I = N - P$. If the species of even mass ($M = P + N$) are plotted as a function of *P* and *I* for meteorites, planets and stars, the species of even mass fall into continuous series, except for five blanks, with every odd *P* missing, but (1) *each* of these five undiscovered species occurs *adjacent* to the end of a shell, where the abundance is high.

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[*] Navy contract ONR-271-16.

In the series of odd mass there are only seven undiscovered species, but (2) each of these is "forbidden" by the principle that both of two adjacent isobars are not stable unless the difference in nuclear spins is very large.

At present 107 stable atomic species of even and 108 of odd mass, or 275 in all, are known. The principle of continuity alone indicates five additional species of even and eight of odd mass, but in each of these 13 cases either relation 1 or 2 above indicates a probable instability. Thus it is not improbable that all of the stable species are now known.

Stars with Atmospheres of Glowing Hydrogen

Paul W. Merrill

Mount Wilson and Palomar Observatories

Stars whose outermost strata are unusually active offer special inducements to astrophysical research. The first problem is to find them. The classical method has been to search for stars that vary in brightness. But this method does not cover the whole field because rapid motions and other interesting phenomena occur in certain stars that exhibit no appreciable variations in brightness. This is particularly true of hot stars with extensive atmospheres containing glowing hydrogen. These atmospheres cannot be seen or photographed directly but may be detected by the bright hydrogen lines they add to the stellar spectrum.

The Mount Wilson search for bright-line objects, begun in 1919, combined the advantages of objective-prism photography with the use of the red Hα line, the strongest accessible line of hydrogen. Of the 1000 bright-line B-type stars now known about 800 have been discovered in the Mount Wilson survey. A number of these are of interest because of phenomenally rapid atmospheric motions. In DM−27° 11944 an outflow of gas at the rate of 300 km/sec has continued since 1921. In 48 Librae a mighty atmospheric oscillation began in 1934; it has a period of about nine years with heavy damping. In the shell star HD 193182, 40 hydrogen lines have been photographed in the Balmer series.

Two important related investigations have grown out of this program. One is the discovery by R. Minkowski of 200 planetary nebulae; the other, the discovery by A. H. Joy of 40 T Tauri stars near the edges of dark galactic clouds.

Some Problems of the Evolution of Stars

Otto Struve, *Yerkes Observatory*

Shapley has shown that the W Ursae Majoris eclipsing binaries are more numerous that all other eclipsing variables taken together. These strange systems consist of two late-type stars, almost in contact, of about one solar mass ~~and one-half solar mass~~, respectively, both slightly smaller than the sun. They are surrounded by a common gaseous envelope which is unsymmetrical in thickness and other physical properties, suggesting that the binary is not a stable formation but that it may develop either in the direction of forming ultimately a single star or of separating into a wider pair. Each binary system carries with it a large amount of angular momentum. Yet there are not now known any single stars with the required angular momentum which could be regarded as the parent stars or as the descendant stars of these binaries. They may have originated from early-type binaries of the kind of β Lyrae or U Cephei through prominence action in their advancing hemispheres, resulting in the production of gaseous streams. These streams not only carry off mass at a rate of not less than 10^{-8} × sun's mass per year but they also carry off angular momentum in a manner that is not altogether different from the mechanism suggested in 1947 by v. Weizsaecker. If this process of evolution should continue then the common gaseous envelope of a W Urase Majoris system may be identified with the v. Weizsaecker nebula giving rise to the beginning of a planetary system and thus the slow rotation of the resulting single stars can be explained.

Values as a Subject of Natural Science Inquiry

A. L. Kroeber, *Columbia University*

"Human values" are defined as human products forming part of human culture and hence as fully natural phenomena, subject to study by the methods of natural science. Any extranatural or supernatural properties sometimes ascribed to values may therefore be ignored. *De facto*, anthropologists and others have actually often dealt with value from a genuinely scientific attitude, though not always aware of the fact. The importance of values is in their organization and integration of culture. This function is more readily discerned than the specific causes which produce values.

Forecasting Features of Washington Weather

C. G. Abbot, *Smithsonian Institution*

Author publishes annually "preferred" dates for precipitation at Washington based on the rotation period of the sun. For 15 consecutive years the average daily precipitation on "preferred" dates has been above that for all others. The 15-year average ratio is 1.46, the expected ratio 1.42.

In January 1948 author deposited a sealed list of 55 dates in 1948 which he predicted would be near dates of minimum temperature at Washington. He predicted that between these pairs of dates would lie others averaging for the year 7.1° F higher. The director of the Astrophysical Observatory opened the package January 19, 1949, and certifies that on 48 out of 55 cases warmer days did thus intervene. Their average excess was 6.96°, as against 7.1° predicted. The prediction is based on a 6.6456-day regular period in solar variation. Author claims this solar influence nearly completely accounts for the short interval fluctuation of temperature in weather. He believes similar predictions would succeed anywhere.

Structure and Dynamics of the Thunderstorm

Horace R. Byers, *University of Chicago*

From the extensive and detailed data obtained by the Thunderstorm Project in Florida and Ohio, a model of a thunderstorm has been established. There are several more or less independent convective systems of "cells" which make up the thunderstorm. Each cell goes through a life cycle represented by three fairly distinct stages—the cumulus stage, the mature stage, and the dissipating stage.

In the cumulus stage the cell is formed from an updraft of air which, as in the other stages, "entrains" air from the environment. In this stage no rain has yet reached the ground. In the mature stage, rain is occurring and a large part of the cell consists of a downdraft which coincides with the rain area. The updraft continues in a portion of the cell. In the dissipating stage downward motion predominates.

In a study of the thermodynamics involved in these circulations it is shown that the entrainment of environment air into the cells has important effects. The significance of falling rain in starting the downdraft is shown. The downdraft consists of cold air that reaches the ground and spreads out over the surface of the earth, producing marked changes in the wind, temperature, and pressure. The thunderstorm derives energy from the downdraft as well as from the updraft.

The Panama Land Bridge

W. P. Woodring, *U. S. Geological Survey*

The Panama land bridge is more fantastic in outline than many land bridges that have foundations no more secure than the imagination of paleogeographers and zoogeographers. Inasmuch as it still is a bridge in being and ample evidence indicates that it has been in continuous operation since late Tertiary time, its record may serve as a test for the performance of hypothetical bridges. Unlike many hypothetical bridges, it was not narrowly selective to potential users—indeed, it was less selective than it now is—and it accommodated two-way traffic, as every genuine bridge should, although the southbound lane was more crowded than the northbound. According to vertebrate paleontologists familiar with the Tertiary land mammals of North and South America, the Panama bridge was completed and open to traffic immediately after the end of middle Pliocene time, about 5 million years ago. The first North American migrants, however, reached South America in the late Miocene or early Pliocene, and the earliest South American invaders reached North America in the middle Pliocene. These first arrivals in both continents were small animals and presumably reached their destination by using still separated spans and completed piers as stepping stones.

A land bridge is also a sea barrier, and erection of the Panama bridge evidently had a profound effect on marine animals in the Caribbean Sea. Sweeping extinction of scores of genera, which may be designated paciphiles, as they are still living in the Pacific Ocean and probably had their origin there, took place in the Caribbean Sea during and immediately following early Pliocene time. On the contrary, very few caribphiles became extinct in the eastern Pacific Ocean, possibly because the ancestral eastern Pacific Ocean was a much larger body of water than the ancestral Caribbean Sea, and therefore was not so greatly affected by disruption of long-established circulation of ocean water masses through Central American seaways.

The Principles of Generalized Harmonic Analysis Applied to Ocean Wave Data

H. R. Seiwell, *Woods Hole Oceanographic Institution*

(Introduced by John A. Fleming)

A fundamental problem of sea surface wave research is the reduction of the wave patterns (variations of wave height with time) to their basic physical characteristics.

The periodogram analyses of ocean wave records have resulted in claims of bewildering combinations of frequencies making up single patterns. It is suggested that usual methods of periodogram analyses are inadequate for this purpose in that they do not reveal the physical characteristics of the situation.

Consideration of the relationship between the wave spectrum and its autocorrelation function, from the viewpoint of generalized harmonic analysis, provides a more realistic and simplified approach to the evaluation of ocean wave data. This method, new to oceanographic analyses, describes the physical properties of the data, and may be employed in discovering their physical causes. The autocorrelation function gives all the information that can be obtained from an ordinary periodogram analysis and such additional information as obtained by the power of all frequencies considered continuously.

Analyses of more than 30 ocean wave records scattered over the North Atlantic have revealed that in every case the wave pattern was reduced to a cyclical component on which were superimposed damped oscillatory and random components. Periods and amplitudes are readily computed which, together with varying relationships between the components, characterize the physical properties of the wave patterns.

The geophysical interpretation of results is that in sea surface roughness patterns the cyclical component is predictable, and appears to be generated by the influence of a dominating oceanic meteorological situation over the ocean. The oscillatory and random components result from the effects of local winds and other local disturbances tending to change basic ocean wave pattern.

Earthquakes and Rock Creep

Hugo Benioff, *Seismological Laboratory, California Institute of Technology*
(Introduced by Beno Gutenberg)

A method, based upon the modified instrumental magnitude scale of Gutenberg and Richter, is developed for determining the elastic rebound strain increments associated with earthquakes of a particular fault system. It is shown that a graph of the accumulated increments plotted against time for a given sequence of aftershocks or earthquakes represents the creep behavior of the fault rock.

Application of this method to the study of a number of aftershock sequences indicates that aftershocks are produced by the elastic afterworking or creep recovery of the strained fault rock. In some sequences the recovery assumes a dual form in which the first phase represents compressional afterworking and the second phase shear afterworking. Applied to earthquake sequences, the method provides a new means of observing tectonic processes in action. Movements corresponding to constant flow, exponentially increasing flow, and strain hardening creep are observed in different sequences and at all seismic focal depths. Evidence is offered to show that the South American and Tonga deep sequences represent single mechanical fault structures with linear dimensions of 4500 km and 2500 km respectively, and that the oceanic deeps associated with these structures are surface expressions of these great faults.

Early Tertiary Ecotones in Western North America

Ralph W. Chaney, *University of California*

The fossil plant record gives little support for the idea that climates have been uniform across many degrees of latitude in past ages. Far from being cosmopolitan, the floras of the Tertiary period show marked zoning; in western North America there was temperate vegetation in Alaska during the early part of the period, and subtropical forests occupied middle latitudes as far north as Washington and Wyoming. Between these zones there developed ecotones containing some of the more hardy southern plants, and many trees typical of higher latitudes. The dominant conifer was Metasequoia, a deciduous redwood once widely distributed over the northern hemisphere, and now known to live only in central China. The modern Metasequoia forest stands in ecotonal relationship to the subtropical forest of the lowlands in which broad-leafed evergreens predominate, and to the temperate forest of the uplands in which broad-leafed deciduous trees are most common. The survival of this mixed forest, whose observed members include most of the genera associated with Metasequoia tens of millions of years ago, represents an outstanding case of continuity, and provides an accurate basis for reconstructing Tertiary environments over wide areas in ages past.

The Spherical Sections of a General Surface

Edward Kasner, *Columbia University*

The plane sections of a surface S form a triply infinite family of curves. The spherical sections form a quadruply infinite family. When these curves are mapped on a plane, the differential equation is of the fundamental type

$$y'''' = Ay'''^2 + By''' + C$$

which occurs in many dynamical problems and in the calculus of variations. The infinity of curves passing through a given point in a given direction have the property that the centers of the osculating conics themselves lie on a conic. The spherical curves of S may be regarded as another analogue of circles (in contrast to the standard definitions of Gauss and Minding).

All fields of force whose trajectories are plane curves were found by Halphen. The analogous problem for spherical trajectories is solved in the present paper.

Homotopy Groups of Certain Algebraic Systems

Paul A. Smith, *Columbia University*

Let Y be a groupoid in which there is singled out a subset Z of elements satisfying certain conditions. We define certain groups $p_n(Y, Z)$ determined by Y and Z. The groups p_1 and p_2 can be identified as first and second homotopy groups when the elements of Y and Z are suitably interpreted. Other interpretations lead to new results in the theory of abstract local groups and their extensions. In this direction we are led for example to a new proof of the existence of Lie groups in the large.

Production of Mesons by X-Rays

Edwin M. McMillan and Jack M. Peterson
University of California

The first experimental program to be undertaken with the Berkeley synchrotron is a study of meson production. The emergent beam of 335-Mev X-rays passes through a stack of nuclear plates (Ilford F-3), or through a slab of matter in the vicinity of such plates; then meson tracks in the emulsion are sought by microscopic examination. The results prove conclusively that mesons are produced, and that they are not the result of secondary heavy particles and most probably not the result of secondary electrons. A very rough estimate of the cross section for meson production by X-rays in glass is 8×10^{-30} cm^2 per nucleon. The number of quanta is here defined as the total X-ray energy divided by the peak quantum energy. Since only mesons with energies below about 20 Mev will stop in the stack of plates and be counted, the actual cross section may be considerably larger.

Out of a total of 145 tracks recorded, 91 end in stars. Assuming that three quarters of all negative π mesons produce stars, and that every positive π meson is accompanied by a μ, this leads to a ratio negative π/positive $\pi \sim 10$. The actual π–μ decay is not always discernible on these rather insensitive plates; only five cases have been seen. The statistics given above include mesons from both glass and carbon, and in both cases the excess of negatives is apparent.

This work was done under the auspices of the Atomic Energy Commission.

Neutron-Proton Interaction

A. A. Broyles and M. H. Hull

Yale University[*]

(Introduced by Gregory Breit)

The work of Rarita and Schwinger, while successful in accounting for the experimental value of the quadrupole moment of the deuteron, reduces the central field part of the potential by roughly 30 percent and implies a thorough revision of the nuclear binding energy calculations of Wigner, Feenberg, and others. In view of the probability from Breit's relativistic arguments that at least part of the tensor interaction does not have the same location in space as the central force, and the possibility noticed by Breit of obtaining closed solutions by confining the tensor potential to an infinitely thin spherical shell, the problem was reinvestigated. It was found that the quadrupole moment can be accounted for by placing the shell beyond $r_1 = 7\ e^2/mc^2$ from the center of force and that for $r_1 = 1.5\ e^2/mc^2$ the central field need be decreased by only about 2 percent. The triplet cross section at zero energy changes from 4.40 to 4.46 barns as r_1 changes from 1 to 1.5 (e^2/mc^2) while the central field square well range is $r_0 = e^2/mc^2$ and from 3.95 to 3.62 barns for $r_0 = e^2/2\ mc^2$. These effects are small and there remains the possibility of leaving the central field relatively unaffected by the addition of the tensor force. This work is related and is in general agreement with that of Guindon but deals with more pronounced effects.

Electromagnetic Induction in a Superconductor

W. V. Houston and C. F. Squire, *The Rice Institute*

No completely satisfactory atomic theory of superconductivity has been devised and it is important to investigate the phenomenon in various ways to be sure that even its macroscopic description is correct.

The law of electromagnetic induction can be illustrated with a Faraday disk. This is a conducting disk rotating in a magnetic field parallel to its axis. By means of sliding contacts near the axis and at the rim, the induced electromotive force can be observed.

To investigate the induction in a superconductor, a Faraday disk was built of lead, in the form of a flattened spheroid. It was mounted to be operated in a cryostat and the induced electromotive force was observed above and below the transition temperature of the lead.

It might be expected that no electromotive force would be produced below the transition temperature. In the first place a potential difference is not expected to exist across a superconductor. More convincing still is the fact that the magnetic flux does not pass through the superconductor, but is forced to go around the disk. Nevertheless the experiment showed almost no difference between the electromotive forces above and below the transition temperature. The small observed difference can easily be attributed to the experimental arrangement.

Although this result is somewhat surprising, it is consistent with observations reported by K. Onnes in 1924, which showed that a persistent current in a lead sphere could not be rotated into a different plane by means of a magnetic field.

Lorentz-Type Transformations as Derived from Performable Rod and Clock Operations

Herbert E. Ives, *Upper Montclair, New Jersey*

The Lorentz transformations are mathematical formulae calculated to leave the electromagnetic equations unchanged in form in relatively moving systems. In them the "local time" figures as a necessary substitution; the operations for establishing it were not developed. Einstein, while emphasizing the importance of performable operations, nevertheless bases his development on a *definition*, which requires that the measured time of transit of a light signal *sent in one direction* shall be half that of a signal *sent out and back*. The latter operation (the usual method of measuring the velocity of light) requires *one* clock, at the origin, the former *two* clocks, and the method of setting the second clock is the fundamental problem if Einstein's definition is to be replaced by a physical operation.

The problem is solved by using a "setting clock" which is moved at an observed velocity to the distant point, the "time" being determined by the setting clock itself. What the setting clock reading will be is derived from the contractions of length and clock rate as postulated by Fitzgerald and Larmor, and, in the case of clock rate, established by experiments on canal rays. The resulting transformations contain terms involving the observed setting clock velocity. The velocity of light, as measured by signals sent in one direction, is not, as by Einstein's definition, the same as for out and back signals, but is a function of the setting clock velocity. When the setting clock velocity is negligibly small the relations become the original Lorentz transformations.

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[*] Assisted by joint program of the Office of Naval Research and the Atomic Energy Commission.

Duration of Phosphorescence of Metal Organic Complexes

S. I. Weissman and Philip H. Yuster

Washington University

(Introduced by Arthur H. Compton)

The coordination compounds of dibenzoyl methane with various metal ions exhibit photoluminescence of long duration. Although the spectral nature of this luminescence is almost independent of the metal ion, its duration is markedly dependent on the nature of the ion. The experimental observations are interpreted through G. N. Lewis's identification of phosphorescence as a transition between states containing different numbers of unpaired electrons. The probability of such a transition is sensitive to small departures from perfect pairing or from complete unpairing of electrons in the various states of a molecule. These departures result from spin-orbit interaction, i.e., interactions of electronic spins which are dependent on the positions of electrons.

Such interactions in the series of compounds here discussed arise from the motion of the electrons of the organic complexing agent through the electric fields of the nuclei of the metal ions, and from motion of the electrons in the inhomogeneous magnetic fields of paramagnetic ions. The effect of an inhomogeneous magnetic field is demonstrated by a fiftyfold decrease in duration of the phosphorescence of the complex with the paramagnetic gadolinium ion over the duration of the phosphorescence of the complex with the chemically similar but nonmagnetic lutecium ion. The effect of nuclear charge is shown by a tenfold decrease in duration of the phosphorescence of the lanthanum ($Z = 57$) compound over the aluminum ($Z = 13$) compound.

The results indicate that small departures from perfect pairing and unpairing of electrons in organic molecules, although they produce only insignificant effects on the energies of the molecules, are decisive in determining rates of certain photoprocesses.

A New Method for Measuring the Limiting Negative Pressure in Liquids

Lyman J. Briggs, *National Bureau of Standards*

In this method the liquid under examination is held in a capillary tube *open at both ends*. About one centimeter from each end the tube is bent back upon itself through an angle of 140° to form a Z. The tube is cemented symmetrically to a horizontal spinner mounted on the upper end of the vertical shaft of a high speed motor. It spins in its Z-plane with its *center intersecting the projected spin axis*. Consequently the liquid column at this point is visible even at high angular speeds. The breaking of the column is signalized by a marked change in the refraction of the tube.

In the centrifugal field, one half of the liquid column is pulling against the other. The maximum stress is at the center. The effective length of either half is the distance from the spin axis to the meniscus in the bent leg of the tube. If these distances are not equal when the motor starts, one meniscus immediately retreats and the other advances until equilibrium is restored.

The open-ended tube possesses the great advantage of being easy to clean and fill. Scrupulous cleanliness is necessary in measuring negative pressure. To facilitate filling, the open ends project slightly beyond the side of the supporting spinner. Use of a capillary tube also reduces to a minimum the solid surface in contact with the liquid and reduces the effect of vibration. Measurements are made under an absolute pressure of 3 or 4 cm Hg.

Preliminary measurements indicate that the limiting negative pressure of water as determined by this method is 223 ± 5 negative atmospheres at 27° C. This is equivalent to a vertical column of water 7400 ft high hanging from the closed top of the tube which contains it.

Thermoluminescence as a Research Tool

Farrington Daniels, Charles A. Boyd, and Donald F. Saunders

University of Wisconsin

Light may be emitted when a crystal is exposed to X-rays and heated gradually. Its intensity increases and decreases, giving peaks in an intensity-temperature curve, which correspond to different activation energies for trapped electrons. The characteristic curves can be used in studying the nature of the crystal and its previous history, its chemical impurities, its physical imperfections, and the kinetics of the release of stored energy. They are helpful also in comparing crystalline material from different sources, in correlating lattice distortions produced by mixtures as in the case of NaCl and NaBr, and possibly in evaluating the expected behavior of heterogeneous catalysts.

Many igneous rocks, limestones, and other minerals exhibit thermoluminescence due to radioactivity from traces of uranium or thorium. Even less than one part per million, with an accumulative effect over millions of years, may give a more sensitive test for radioactivity than a Geiger-Mueller counter. After being once heated the minerals lose their thermoluminescence, but brief exposure to X-rays restores this property. Uranium content, age, impurities, and imperfections are some of the factors in the thermoluminescence which are now being studied.

Some of the energy of radioactivity in rocks is dissipated as heat and carried away by conduction, but part can be stored as potential energy of displaced electrons (and atoms). After the latent traps are filled the temperature rises and the stored, potential energy can be released quickly in a manner similar to that observed in thermoluminescence. This hypothesis of rhythmic heating may have implications in geology.

The New Particles of Matter

Carl D. Anderson, *California Institute of Technology*

Some of the properties of the elementary particles of matter were discussed briefly, with emphasis on the results of recent studies of mesons. Reference was made to the phenomena concerned with the production and annihilation of μ and π mesons. The results of recent experiments in cosmic rays which show that the μ meson disintegrates into an electron and two neutrinos were presented. The bearing that these results have on the mass and spin of the μ meson was discussed.

The Study of an Iodide-Iodine Complex by Means of the Electromotive Force Centrifuge

Duncan A. MacInnes
Rockefeller Institute for Medical Research

B. Roger Ray, *University of Illinois*

The potential E of a galvanic cell consisting of two iodide-iodine electrodes at different radii in a centrifugal field was measured at a series of rates of rotation n. It was found that, when disturbing influences were eliminated, the ratio E/n^2 was accurately constant in each experiment. A series of determinations were made in which the solution in the cell was potassium iodide with varying proportions of iodine. The results indicated that the usual equation relating the potential E to the transference number, the radii, the molecular weights, etc., is correct only in the limit of zero concentration of iodine. For finite concentrations of iodine the equation must be modified to include the effect of an iodide-iodine complex on the mechanism of the cell. The measurements are in complete quantitative accord with a complex of the composition I_8^-. The results also yield values of the transference number of potassium iodide in close agreement with determinations by the moving boundary method.

Individual Metabolic Patterns, Alcoholism; Genetotrophic Diseases

Roger J. Williams, L. Joe Berry, and Ernest Beerstecher, Jr.
University of Texas

Distinctive metabolic patterns in individuals are probably due to commonplace partial genetic blocks which give rise to augmented requirements for specific nutrients and hence to altered metabolisms.

Rats and mice with diverse genetic backgrounds exhibit individual responses with respect to alcohol consumption. Some abstain indefinitely, some consume moderately, some are irregular, others steady. Some animals consume relatively heavily beginning the first day, others do so only after several weeks. These responses are genetically controlled; animals with the same genetic background exhibit uniform responses.

Alcoholic consumption in all these animals can be raised ultimately to a high level or reduced to nearly zero, depending on whether or not their nutritional needs are completely met. The alcoholic consumption of certain strains of animals and certain individual specimens is relatively difficult to reduce. Clear evidence is presented that diverse deficiencies in different animals are responsible for the creation of an appetite for alcohol.

These findings suggest the broader concept of genetotrophic (geneto = genetic; trophic = nutritional) diseases of which alcoholism is thought to be one. On the basis of genetic variations one individual may suffer from nutritional disease on a diet wholly satisfactory for others. The possibility that genetotrophic factors are operative in numerous diseases of obscure etiology, e.g., allergies, mental diseases, cardiovascular diseases, arthritis, multiple sclerosis, drug addiction, and even cancer, requires exploration.

Psychological and social influences doubtless play a role in alcoholism and in "mental diseases" generally, but an investigation of biochemical factors demands far more emphasis than it has received.

On the Central Zone of the Human Fovea

Walter R. Miles
Yale University School of Medicine

An observer's attention may be directed to perceptual material presented at any part of the visual field. But it is relatively easier to pay attention to central rather than to far peripheral areas. Our usual experience seems to indicate radiating gradients of decreasing psychological clearness extending from the point of fixation in all directions on the visual plane. Under optimal illumination we see best, quickest, and with most satisfaction visual images formed on the fovea immediately around the point of fixation. Our eyes are highly mobile and ordinarily turn appropriately to bring interesting visual material into "full gaze" on the fovea. The receptor elements (cones) in this region are highly sensitive to fine detail and color, and the region is spoken of as the "rod-free" area. The over-all diameter of this nearly circular spot, the fovea, is commonly given as from 3° to 5°.

Concentric zonation within the fovea itself may be demonstrated and plotted by the use of special filters and a technique which we have previously reported. In normal eyes it is characteristic to find a central disc area about 30′ in diameter which in certain ways seems functionally distinct from immediately surrounding areas. In our experimental findings the subject's fixation point always falls within this disc, which comprises a relatively small population of elongated cones. Usually fixation falls very close to the center of the foveal disc. Results are reported on the location and variation of the positions of the fixation points for pairs of eyes in a sample adult population, and on the relation of positive scotoma to fixation position. Implications of fixation of the line of regard near the center of a "favored" group of specialized optic nerve endings are suggested.

The Cortical Correlate of Pattern Vision

Wolfgang Köhler and Richard Held
Swarthmore College

During recent years, the question has arisen whether the activities of the human brain are throughout of the same kind as the events which are known to occur in peripheral parts of the nervous system, namely, nerve impulses. Both psychological and physiological evidence has been accumulating according to which functional interrelations in the brain are partly mediated by a continuous field action. Moreover, from the investigation of certain facts in visual perception it has been inferred that this field action consists of direct currents which spread through the brain as a continuum. This thesis has been subjected to direct physiological tests by the authors, and has been found to be correct. The currents can be registered from the intact heads of human subjects. The behavior of the currents agrees with available knowledge about the anatomy of the visual cortex and with predictions from biophysical theory. Rival interpretations of the results have so far been refuted. The authors do not suggest that their observations are at odds with more familiar facts in neurophysiology. On the contrary, they are convinced that the new facts are directly related to the arrival of nerve impulses in the brain. They point out, however, that psychological experience and cortical events are likely to be much more sensibly connected if brain action is mainly a matter of field physics than they would be if brain action consisted only of nerve impulses.

The Developmental Aspect of Child Vision

Arnold Gesell, *Yale University*

Under a cooperative program of research over a period of 10 years, the Yale Clinic of Child Development has made periodic studies of the visual functions of normal infants and children of preschool and school age. These studies are concerned with the progressive organization of visual functions in their relationship to the action system of the growing child at a score of age levels. Five functional fields have been explored in a preliminary manner: 1) eye-hand coordination; 2) postural orientation; 3) fixation; 4) projection; 5) retinal reactions. The data were gathered by means of developmental examinations of behavior patterns; naturalistic observation of spontaneous and adaptive behavior at home, school, and guidance nursery; graded tests of visual skills; optometric tests; and examinations by streak retinoscope (without cycloplegia).

The retinoscopic findings in conjunction with other findings indicate that the visual mechanism is in a somewhat labile condition, both dynamically and developmentally. Superimposed upon a basic delimiting refractive state there is a margin of adaptability which is manifested in the brightness, the motion, the direction, and the speed of the retinal reflex. Developmental stages can be differentiated according to the child's visual manipulation of space.

The visual system and the unitary action system prove to be intimately and reciprocally related. The child sees with his total makeup. Acuity is only one aspect of the economy of vision. From the standpoint of a developmental optics, visual functions can be interpreted in terms of their dynamic relation to the maturity and operations of the basic action system. This has implications for visual hygiene. Eye care involves child care.

Audition—A Physiological Survey

Hallowell Davis
Central Institute for the Deaf, St. Louis, Missouri

An important trend in the study of audition is the coordination of many points of view, from engineering through biophysics and physiology to psychology. Increasing attention is being directed to the problem of transmission of information. This orientation yields a common frame of reference.

The physical action of the ear as an analyzer of sound is now fairly well understood, and the place principle of pitch perception is generally accepted with minor reservations. In the nervous system the all-or-none principle of nerve action defines the physiological code of transmission, i.e., a dot-dot-dot system of signals at various rates over thousands of parallel conductors. The gap between nerve impulses and consciousness, however, is as wide as ever.

An unsolved problem in the biophysics of audition is the mechanism of excitation of nerve impulses in the sense organ. The attractive theory of electrical stimulation by the aural microphonic (an electrical effect generated in the sense organ by sound) requires additional hypotheses to reconcile it with some of our recent observations. In neurophysiology also special hypotheses are required to explain the great ability of the ear to discriminate differences in the pitch and also in the loudness of sounds. A possible explanation may be that subsystems of nerve fibers and perhaps sensory cells as well may be specialized separately for such discriminations. The more refined discriminations of pitch and intensity require more time than simple detection of a signal. This suggests more complicated interactions between nervous pathways within the nervous system. The kind of specialization that we suggest seems particularly probable for the fine discrimination of time differences between similar signals reaching the two ears. It is on these small time differences that much of our ability to identify the direction of the source of sounds depends.

The Effect of Protein Depletion on Acquired Immunity in Trichinosis

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University of Chicago

Prolonged protein depletion in rats has been shown to lower immunity to trichinosis acquired on adequate diets. The two antibodies described by Oliver-González as being active against adult worms in the intestine and larvae in the muscles were differentially affected. A low protein diet for seven days prior to and continued during infection reduced the antilarval antibody but not the antiadult antibody. A similar low protein diet started 33 or more days before infection reduced both antibodies, and the adults were not expelled from the intestine as effectively. This differential action on the antibodies by the seven-day preliminary depletion can be correlated with the fact that adults liberate antigen before protein depletion is marked, whereas larvae liberate antigen later, after protein depletion has become pronounced.

Histological studies indicated that trichinosis resulted in a marked hyperplasia of the spleen and mesenteric lymph nodes which was less marked in the animals depleted 10 weeks prior to and during infection. The worm larvae in depleted as contrasted with the adequately fed animals were associated with smaller mononuclear accumulations and fewer eosinophils on the average. These differences in inflammatory response are probably due to the lower antibody response in the depleted animals.

The State in Nature of the Active Principle in Pernicious Anemia * of Catalase, and of Other Components of Liver†

Edwin J. Cohn, Douglas M. Surgenor, Richard W. Greene, Margaret Hunter, F. W. Kahnt, and others‡

Harvard Medical School

The outstanding result of our study of the components of blood was the observation that few of the nonprotein constituents were free, and many were in very specific if more or less labile combination with one or another plasma protein. This suggested that nonprotein, and many protein, constituents exist in tissues in combination with proteins.

Nitrogenous constituents of the body have generally been extracted by procedures which allowed chemical or enzymatic dissociation of natural complexes and have been investigated following protein denaturation. The fractionation and crystallization of proteins in alcohol-water mixtures at subzero temperatures have yielded a series of plasma components more nearly in the state in which they exist in nature.

In liver, an organ with many components in equilibrium with plasma, the active principle effective in pernicious anemia has been extracted and reprecipitated in combination with a protein fraction. Catalase has been separated in another fraction in combination with another protein from which it is readily split and crystallized as the free protein. Still other fractions contain the desoxy- and ribonucleoproteins and the various enzymes of liver.

These investigations open the way for the study of the histological locus of the component in the tissue and of the mechanism of release from the tissue.

Sickle Cell Anemia, a Molecular Disease

Linus Pauling, Harvey A. Itano, S. J. Singer, and Ibert C. Wells

California Institute of Technology

The nature of the phenomenon of sickling of erythrocytes in sickle cell anemia suggests that this disease involves a pathological state of the hemoglobin molecule. The electrophoretic behavior of hemoglobin from individuals with sickle cell anemia and from normal individuals has been studied with the Tiselius apparatus. Both ferrohemoglobin and carbonmonoxyhemoglobin from sickle cell blood and from normal blood were studied in phosphate buffers of 0.01 ionic strength at pH values of 5.7, 7.0, and 8.0. A significant difference was found between the electrophoretic mobilities of hemoglobin derived from sickle cell blood and from normal blood. The curves of mobility against pH are roughly parallel, the iso-electric point of normal hemoglobin being lower than that of sickle cell hemoglobin for each compound. At pH 7.0 sickle cell carbonmonoxyhemoglobin moves as a positive ion while normal carbonmonoxyhemoglobin moves as a negative ion. The most plausible explanation for the observed difference in mobility is that there is a difference in the number of acidic or basic groups in the two hemoglobins, amounting to three or four such groups per molecule. The existence of this difference in the nature of the hemoglobin suggests that the disease itself is a molecular disease, and that the change in shape of the erythrocytes leading to its symptoms is the result of the difference in the properties of the molecules. A possible mechanism for this phenomenon is proposed.

Enzymatic Studies of Cellular Organization

Berwind P. Kaufmann

Carnegie Institution of Washington

(Introduced by M. Demerec)

In an approach to problems of the nature and specificity of action of genes in higher organisms, cytochemical methods, utilizing carefully purified enzymes in combination with various staining procedures, were developed to determine the distribution and interrelations of nucleic acids and proteins in dividing cells of a series of plants and animals. Patterns of distribution were determined by exposing smears or sections of tissues, preserved in a variety of fixatives, to the selective action of purified enzymes—such as ribonuclease, desoxyribonuclease, and pepsin—that degrade specific materials without disrupting visible structural continuity. Patterns of association between nucleic acids and proteins were revealed by successive treatments with different enzymes, or enzymes and chemicals. Thus experiments using ribonuclease, pepsin, and trichloracetic acid independently and in combination revealed that much of the ribonucleic acid in fixed cells exists in association with nonhistone (tryptophane-containing) protein, and that there is in condensed chromosomes a type of ribonucleoprotein which increases and decreases in the cycle of mitosis and is presumably related to the control of genic activity. Similar experiments using desoxyribonuclease indicated that desoxyribonucleic acid is in part associated with the histone type of protein. These experiments also showed that the structural continuity of the chromosome is not destroyed by hydrolysis with desoxyribonuclease, ribonuclease, or pepsin. However, it is destroyed by hydrolysis with either chymotrypsin or trypsin, or by pepsin after removal of nucleic acids.

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* Clinical assay has been carried out with the collaboration of a committee of the Hematology Study Section, National Institutes of Health, Bethesda.

† Large scale fractionation of liver has been carried out with the collaboration of Drs. Jules D. Porsche and James B. Lesh of the Armour Laboratories, Chicago.

‡ Including Bo Norberg, Sweden, in 1946–47; Gustave Derouaux, Belgium, and Hans Nitschmann, Switzerland, in 1947–48.

Sexual Behavior as a Function of Androgen Concentration

Frank A. Beach[*]

Yale University

(Introduced by Walter R. Miles)

It is well known that the reduction or loss of sexual capacity which usually follows castration in male animals can be prevented by administration of exogenous androgen. This fact has been established by experiments upon birds, reptiles, and mammals. Less systematic observations of hypogonadal patients indicate that in some cases androgen therapy occasions an increase in the erotic responsiveness and potency of human males. In no instance, however, have the behavioral effects of different dosages been carefully examined. This was attempted in the present study. Male rats were observed in a series of tests with receptive females before and after castration. Following the operation testosterone propionate was administered by daily injection, different concentrations being employed for five groups of animals. A control group received plain sesame oil and others were treated with 1 to 500 μg of hormone every 24 hr. Approximately 50 μg per day maintained mating behavior at preoperative levels. An equivalent daily dose for a 175-lb man would be approximately 13 mg of testosterone propionate. In rats receiving smaller amounts of hormone response to the female occurred less promptly. The frequency of intromissions and ejaculations was reduced and the rest periods following orgasm became longer. These animals showed symptoms usually associated with human hypogonadism. Administration of 100 or 500 μg of androgen per day produced a rise in the number of ejaculations occurring in a time-limited test, increased the speed with which mating was begun, and shortened the post-ejaculatory rest period.

Inhibition of Plant Growth by Protoanemonin and Coumarin and Its Prevention by BAL

Kenneth V. Thimann and Walter D. Bonner, Jr.

Harvard University

It has been suggested in a previous paper that unsaturated lactones exert their growth-inhibiting effects on plants through reaction with a sulfhydryl enzyme. This enzyme is evidently a limiting factor in the growth of isolated sections of oat coleoptile or pea stem and is responsible for growth inhibition by iodoacetate, arsenite, and organic mercurials. In the present paper it is shown that coumarin and protoanemonin inhibit both straight and curved growth, the protoanemonin being 10 to 30 times the more active. At subinhibiting concentrations the growth is promoted in each case. The inhibition is clearly prevented by the addition of dimercaptopropanol, BAL, at concentrations below 3.10^{-4} molal.

It is concluded that coumarin and protoanemonin do inhibit growth by reacting with sulfhydryl enzyme, and that this enzyme is probably the same as that inhibited by iodoacetate and arsenite.

New Evidence on the Origin and Evolution of Maize

Paul C. Mangelsdorf

Botanical Museum, Harvard University

Remains of maize isolated from a cultural deposit in New Mexico and estimated to represent a span of approximately 3,000 years, beginning several millenia B.C., have thrown new light on the problem of the origin and evolution of maize. They show that primitive maize was both a pop corn and a pod corn bearing small corneous kernels enclosed in glumes. The husks which in modern maize completely surround the ear were present in primitive maize but did not yet enclose the ear. There was a progressive increase in average cob and kernel size during the period represented by the remains and a tremendous increase in the total range of variation. The accumulation of variation appears to be one of the most important factors involved in the evolution of plants and animals under domestication and may prove to have an important bearing upon evolutionary processes in nature.

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[*] With the assistance of A. M. Holz-Tucker.

TECHNICAL PAPERS

Isolation of Pituitary Follicle-Stimulating Hormone (FSH)[1]

Choh Hao Li, Miriam E. Simpson, and Herbert M. Evans

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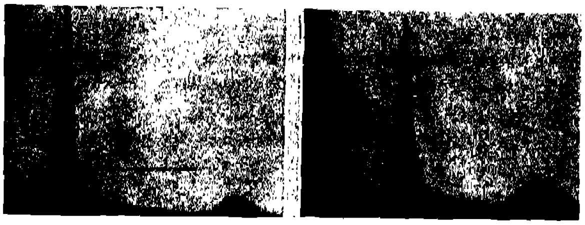
A method is herein reported for the isolation of a protein from sheep pituitaries which causes follicular development only in the ovaries of hypophysectomized rats, and which behaves as a single substance in electrophoresis and ultracentrifugation.



A B

FIG. 1. Electrophoretic patterns of ascending boundaries of two pituitary follicle-stimulating hormone preparations: A—in pH 7.0 phosphate buffer of 0.1 ionic strength, and B—in pH 4.0 acetate buffer of the same ionic strength. The current with a potential gradient of about 6 volts per cm had run for 180 min in A and for 240 min in B. The protein concentration was 1%.

The following procedures were performed at 2° to 3° C:

Ammonium sulfate fractionation: One kg of frozen sheep pituitaries is finely ground and extracted with $Ca(OH)_2$ according to the procedure described previously (*1*). After the removal of the precipitate obtained by adding saturated $(NH_4)_2SO_4$ to half saturation, the supernatant was brought to 0.75 saturation by the addition of solid $(NH_4)_2SO_4$. This precipitate was dissolved in water and dialyzed. A slight precipitate that formed during dialysis was discarded. The clear reddish supernatant solution was adjusted to pH 6.0 and then to pH 4.7. The precipitate formed at either pH was removed by centrifugation. The supernatant was brought to 0.5 saturated $(NH_4)_2SO_4$ by the slow addition of an equal volume of saturated $(NH_4)_2SO_4$ solution at pH 4.7. The precipitate formed was removed and the supernatant again brought to 0.75 saturated $(NH_4)_2SO_4$ by further addition of saturated $(NH_4)_2SO_4$ solution at the same pH. The precipitate was dissolved and dialyzed. The whole procedure was repeated once more, and the final dialyzed solution was frozen and dried in vacuum. This product is called "crude FSH" and may be kept in a desiccator for further use.

Ethanol fractionation: The "crude FSH" powder was next extracted with 0.10 M K_2HPO_4 in 40% ethanol. After removal of the residue, the ethanol concentration in the supernatant was increased to 80% by adding slowly cold 95% ethanol (− 5° C). The ethanol precipitate was dissolved in water and dialyzed.

Further $(NH_4)_2SO_4$ fractionation: The dialyzed solution was adjusted to pH 4.7 and centrifuged if precipitation occurred. A pH 4.7 saturated $(NH_4)_2SO_4$ solution was next added until the concentration became 0.55 saturation. The 0.55 saturated $(NH_4)_2SO_4$ precipitate, found to be devoid of FSH activity, was removed by centrifugation. The supernatant was brought to 0.70 saturation with more pH 4.7 saturated $(NH_4)_2SO_4$ solution; the precipitate formed was dissolved in water and dialyzed. This 0.55–0.70 saturated $(NH_4)_2SO_4$ fractionation was repeated twice.

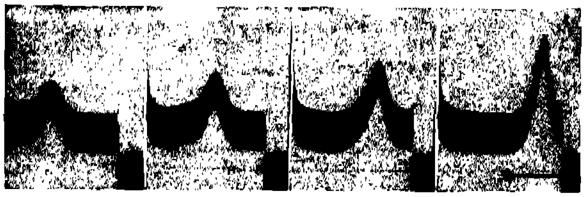


FIG. 2. Four schlieren patterns of a saline solution of the pituitary follicle-stimulating hormone taken at 1020-sec intervals during sedimentation at 105,000 × gravity in an ultracentrifuge.

The final 0.55–0.70 saturated $(NH_4)_2SO_4$ precipitate was examined in a Tiselius electrophoresis apparatus using the scanning method of Longsworth and in a Spinco ultracentrifuge.[2] As shown in Figs. 1 and 2, the pattern obtained by either method was characteristic for a single protein.

All biological assays were carried out in female rats hypophysectomized at 27 days of age. Subcutaneous injections were begun about 7 days later, and were given once daily for 3 days. Autopsy was performed 72 hr after the onset of the injections. Histological examination of the ovaries showed that a total dose of 0.05 mg of the hormone initiated follicular development (increase in follicle size beyond that characteristic of controls and beginning antrum development). On the other hand, a total dose of 2.0 mg of the product administered over a 4-day period did not show interstitial-cell-stimulating, thyrotropic, adrenocorticotropic, or growth-promoting activities, indicating that at this high level the preparation was free of other pituitary hormones.

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[1] Aided by grants from the American Cancer Society (through the National Research Council, Committee on Growth), the U. S. Public Health Service, and the Research Board of the University of California, Berkeley, California.

[2] We are indebted to M. Moskowitz for the ultracentrifugal data.

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Preliminary Report on the Circumpolar Distribution of *Neoechinorhynchus rutili* (Acanthocephala) in Fresh Water Fishes

Harley J. Van Cleave and James E. Lynch

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Early attempts on the part of American helminthologists to establish the identity of individuals of the acanthocephalan genus Neoechinorhynchus found in fishes of the Atlantic coast and species found in Europe have all been repudiated. For many years the writers have been accumulating evidences on the continuous dispersal of *Neoechinorhynchus rutili* in fresh water and migratory fishes throughout the circumpolar regions of Europe and North America. Previously unpublished observations, resulting from examinations of fishes of the northern states, the north Pacific area, Alaska and the arctic regions, furnish a chain of evidence on which broad geographical distribution is established. There is no confirmation of the possibility of this species' extending its distribution through the Atlantic fauna.

The most difficult obstacle encountered in the study has been the inadequate morphological description of *N. rutili*, which has been commonly regarded as a distinctively European species. Detailed studies have demonstrated the identity of specimens from Sweden, Finland, and central Europe, and those taken from Wisconsin, Washington, Alaska, and various regions in Canada, including materials from within the Arctic Circle of the Canadian Northwest Territories.

This constitutes the first authentic demonstration of the occurrence of the same species of an acanthocephalan in fresh water fishes of both Europe and North America. Inhabitants of brackish water and migratory fishes are included in the host list for both continents. There is no evidence to indicate that this widely dispersed species has developed any tendency toward the establishment of distinct varieties or subspecies in the various parts of its range or in its adaptation to a highly diversified list of definitive hosts.

A full morphological and taxonomic description of *N. rutili* is possible on the basis of the present study. This, together with a full account of the geographical and host distribution, will be presented in a full account of the investigation which is to be published elsewhere.

A Photographic Technique for the Detection of Presumptive Biochemical Mutants

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A recent article by Wagner (*2*) describing the photographic recording of Petri plate cultures of microorganisms suggested the possibility of a similar technique for detecting biochemical mutants in colonial microorganisms. The layer plate detection technique of Lederberg and Tatum (*1*), as customarily used in this laboratory, involves the laborious hand-marking of individual wild type colonies to enable the later detection of mutant organisms. Cells or spores treated to induce mutation are plated on a minimal agar medium and the wild type colonies allowed to grow up. These colonies are marked by spotting a drop of India ink on the glass surface of the plate directly below the colonies. Thereupon a layer of agar, containing whatever supplements the investigator is interested in, is poured over the agar surface containing the treated cells. Cells requiring the supplements are thus enabled to grow up. The procedure is concluded by picking the unmarked colonies, which develop after the addition of the supplemented media, and testing them further to determine their mutant status. In crowded plates the individual spotting of colonies is very time-consuming and occasional colonies *may* be overlooked, or the indicator spots rubbed off in handling.

In the photographic method developed here, the treated cells are prepared and plated in the usual way. When the wild type colonies have grown up, the plate is placed upon a piece of high speed, high contrast photographic printing paper with the emulsion side of the paper in contact with the underside of the plate. The plate is momentarily uncovered and exposed to a strong light, and the exposed paper then developed in the usual manner for contact prints. With proper exposure a positive print is obtained in which the white colonies stand out against a dead black background, since the agar layer with colonies acts as a negative. The plate from which the print was made is layered with supplemented media. After an appropriate interval to allow growth of deficient cells the plate is superimposed on the print. The new colonies which grow up are readily detected by comparison with the colonies already visible on the photograph of the original layer, and these putative mutants are picked and tested further. Reference lines and markers to permit easy orientation of plate and print may be drawn on the lower surface of the plate with India ink before photographing. In practice we find Kodabromide F-4 and F-5 to be very satisfactory papers used in conjunction with the light from an enlarger. The exposure time under these conditions is less than 1 sec, and the entire development time about 5 min. A number of plates may be exposed and developed simultaneously by using large sheets of paper.

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[1] Standard Brands, Inc. fellow in microbiology.

The only necessary precautions are the use of an agar layering medium which does not contain granules of undissolved material which might be mistaken for microcolonies, and the selection of Petri plates with unscratched glass bottoms. Ordinary care should be taken to prevent contamination when the plates are uncovered for photographing. It is felt that this method possesses advantages over the usual marking procedure in saving time, increasing accuracy, and providing a permanent record of each plate.

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Sentential and Propositional Generalizations of Salivary Conditioning to Verbal Stimuli

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While conditioned responses to single words have been established by a few investigators, no one, to the writer's knowledge, has studied the course of true conditioning to whole sentences, or propositions. In the present study, salivary CRs were formed in four adult human subjects to three short sentences—"Poverty is degrading," "Roosevelt will be elected," and "Socialism is desirable"—and the generalization of the conditioning to sentences, with reversed "subjects" and/or "predicates" and/or "copulas," was mapped out.[1] The writer's technique of salivary conditioning has been previously described (*1*). It consists essentially of measuring saliva by weighing increments in dental cotton rolls (Johnson and Johnson, No. 3, 0.5/15 in) inserted under the subjects' tongues for a short period of time, usually for 1 min. Since the cotton-in-the-mouth is by no means a totally inactive stimulus, periods of control salivation must be rotated with experimental periods; and, again, to prevent evaporation, scale-corrosion, and absorption, the rolls are weighed in small cellophane envelopes, and reweighed in the envelopes immediately after their removal from the subjects' mouths. Other characteristics of the technique are: (1) multiple intermittent 1-sec presentations of stimuli-to-be-conditioned, during single continuous eating periods of 2–4 min, so as to provide maximum attention for the stimuli and to make the entire task more "molar" and meaningful; (2) misinforming the subjects about the nature of the experiment, so as to forestall disrupting subjective attitudes; and (3) varying the food—small pretzels, tea, sandwiches, lollipops and peppermint candy—in the different eating periods of the experimental sessions, and scheduling the sessions in the late morning or afternoon, so as to insure adequate psychophysiological motivation.

TABLE 1

Generalization of Conditioned Salivation to Sentences: "Poverty Is Degrading," "Roosevelt Will Be Elected," and "Socialism Is Desirable"*

Generalization sentences†	Logical formula	Percent of generalization	Mean of percent
We ⊕ Ul ; De ⊕ Df ; Ca ⊕ Ud	S'CP' ○	50 ; 53 ; 63	58
We × Dg ; De × El ; Ca × Ds	S'C'P ○	40 ; 50 ; 58	52
Po × Ul ; Ro × Df ; So × Ud	SC'P' ○	44 ; 41 ; 51	45
We ⊕ Dg ; De ⊕ El ; Ca ⊕ Ds	S'CP ●	38 ; 31 ; 30	36
Po × Dg ; Ro × El ; So × Ds	SC'P ●	37 ; 28 ; 34	33
Po ⊕ Ul ; Ro ⊕ Df ; So ⊕ Ud	SCP' ●	33 ; 30 ; 30	33
We × Ul ; De × Df ; Ca × Ud	S'C'P' ●	19 ; 28 ; 27	25

* Each entry in the third column is a mean of 64 measurements, 16 for each of the four subjects in the experiment.

† Abbreviations and symbols: We = wealth, Ul = uplifting, De = Dewey, Df = defeated, Ca = capitalism, Ud = undesirable, Dg = degrading, El = elected, Ds = desirable, Po = poverty, Ro = Roosevelt, So = socialism; ⊕ = *is* or *will be*, × = *is not* or *will not be*; S' = reversed subject, P' = reversed predicate, C' = reversed copula; ○ = proposition affirmed, ● = proposition negated.

In this particular experiment, each of the three to-be-conditioned sentences was flashed 30 times, in random order, on a screen for 2 sec—with random intervals of 1 to 2 sec between flashes—during eating periods of 3 min. Ten such eating periods, with random rest periods of ½–1½ min between them, constituted an experimental training session; and after the first two training sessions, came eight training-testing sessions. Each training-testing session consisted of six 3-min eating periods, during which the three sentences were presented, and of six 16-min testing periods, during which the amount of conditioned salivation (1-min experimental minus 1-min control salivation in mg), to the conditioned and to the generalization sentences, was ascertained. Testing periods alternated with eating periods, and in each testing period the CRs of only one conditioned sentence and of its appertaining generalization sentences were determined, so that each sentence—conditioned as well as generalization—was tried twice in each experimental training-testing session and 16 times in the entire experiment. The four subjects were undergraduate college students, and they were divided into two equal subgroups, the procedures for the subgroups differing, however, only in the sequences of testing the CRs.

The results are presented in Table 1. They are given in percent of generalization, that is, the conditioned salivation to the generalization sentences as percent of the conditioned salivation to the conditioned sentences (the latter ranging from 189 to 531 mg per min). For lack of space, the entries in the first column of the table are abbreviated, while the first entry in the second column under *Logical formula* means that each of the three generalization sentences in the first row of the first column was formed from its respective conditioned sentence by reversing the "subject" (S′), keeping the "copula" (C) unchanged, and reversing the "predicate" (P′) of the conditioned sentence, thus affirming (○) its proposition; and the fourth entry in the second column means that each of the three generalization sentences in the fourth row of the first column was formed from its respective conditioned sentence by reversing the "subject" (S′) but keeping unchanged the "predicate" (P) and the "copula" (C) of the conditioned sentence, thus negating (●) its proposition. As seen from the table, the amount of CR generalization was a function of both (a) the general logical equivalence of the propositions in the generalization sentences to those in the conditioned sentences, and (b) the particular verbal similarity of the two types of sentences. The generalization factor of *propositional equivalence* is seen in the greater CR generalization to the sentences in the first three rows, affirming the propositions of their respective conditioned sentences, than to the sentences in rows four, five, and six, negating these propositions, even though the sentences in the latter rows were sententially twice as similar to the conditioned sentences. On the other hand, the significance of the factor of *sentential similarity* is manifest in the differences between CR generalizations to sentences that were propositionally equivalent yet sententially different, such as each of the sentences in the first three rows and each of the sentences in rows four, five, and six—and it further follows from the fact that the generalization to the sentences in the first rows that were propositionally equivalent yet sententially different from their respective conditioned sentences was not complete, but ranged from 41 to 63 percent. The table also appears to show that sentential similarity is itself a complex function, and is more than mere verbal similarity. Thus, comparing rows two and three, and four and six, we learn that reversing the "predicate" produced a greater loss in CR generalization than reversing the "subject," which fact points to both a grammatical factor of *syntax* and a logical factor of the relative contributions of "*concepts*" and "*individuals*" to total propositions. Finally, the table gives some indication that changing "desirable" to "undesirable" resulted in less of a loss of CR generalization than changing "degrading" to "uplifting" and "elected" to "defeated." This apparently means that even pure verbal similarity between sentences must, in its turn, take account of not only the number of identical words between the sentences, but also the intersentential relatedness of nonidentical and even of contradictory words. In a previous study (*2*), the writer found that CR generalizations to single words proceeded both along semantic and along phonetic and graphic relatednesses—though more along the former than the latter—and that finding has since been corroborated by two other investigations in conditioning the galvanic skin response (*3*). It would seem worth while to try out, similarly, the more complex findings of the present study with other responses and techniques. And these techniques need not necessarily be those of conditioning.

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[1] "Wealth is degrading," "Wealth is uplifting," "Poverty is uplifting," "Wealth is not degrading," "Poverty is not degrading," "Poverty is not uplifting," "Wealth is not uplifting"; "Dewey will be elected," "Dewey will be defeated," "Roosevelt will be defeated," "Dewey will not be elected," "Roosevelt will not be elected," "Roosevelt will not be defeated," "Dewey will not be defeated"; "Capitalism is desirable," "Capitalism is undesirable," "Socialism is undesirable," "Capitalism is not desirable," "Socialism is not desirable," "Socialism is not undesirable," "Capitalism is not undesirable."

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The Purification of Phenol for Paper Partition Chromatography

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Since the original work of Consden, *et al.* (*1*) on paper partition chromatography, many workers have sought diligently for a better solvent system than the phenol-water which they used. So far nothing better has been reported even though the phenol-water system is frequently limited in usefulness by the development of extraneous colors, which are particularly harmful when the chromatogram is run in ammonia atmosphere, as it usually is.

In this laboratory, the method has been used for some time to identify amino acids in bacterial culture filtrates. The extraneous colors which were almost always present on the developed chromatogram introduced so much uncertainty that final results could not be presented with any confidence. A project was therefore undertaken to determine the cause of these colors and the possibility of eliminating them. This was finally accomplished and it is thought that the results may be of interest to others.

The colors are probably caused by the catalytic action of heavy metals on phenol. Consden, *et al.* (*1*) believed them to be caused by copper in the paper but it has been determined here that the principal source is from impure phenol and from the distilled water used to dilute it. Present practice is to distill all phenol before use. If in the form of crystals, it is liquefied with 12% water first. It is put into the distilling flask and 0.1% aluminum turnings and 0.05% $NaHCO_3$ are added. Distillation is carried on at atmospheric pressure until the azeotrope is off and then under about 25 mm from a water pump until approximately 20 ml of the almost black residue is left. A 14 mm × 70 cm Pyrex air-cooled tube is used as a condenser.

Before use the water content is adjusted to 25% using triple distilled water which is tested for heavy metals. The water content of the mixture is determined as follows: into a 15-ml centrifuge cone put 10 ml of the phenol-water solution and 500 mg of NaCl; stopper and shake the tube; allow to stand 20 minutes to form the phase boundary. This should be at 1.4 ml when the water content is 25%. The water content may vary from 24 to 28% without a detectable difference in Rf values. It should not, however, be at saturation since if a water layer forms in the chromatographic chamber incorrect results will be obtained.

With phenol prepared in this way extraneous colors are completely eliminated. The amino acid bands are sharply defined and full advantage of the color range is obtained. It should be mentioned that the sample should also be free from heavy metals, particularly Cu, Zn, Fe and Mn. All chromatograms run in this laboratory are run against gravity as described by Horne and Pollard (*3*). An ammonia atmosphere is always used with phenol. With these procedures Rf values confirm very exactly those obtained by Dent (*2*).

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A Method of Automatic Dehydration for Histological Technique[1]

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Heretofore the mechanics commonly involved in the process of dehydration have consisted of manually or mechanically transferring tissues through a series of dehydrating chambers containing the dehydrating agents, or of leaving the tissues in a single chamber and periodically changing the surrounding dehydrating fluids.

A new method is now introduced whereby the tissues are continuously and automatically bathed in a continuous flow of anhydrous dehydrating agent. This is accomplished by the use of an extraction apparatus equipped with a Soxhlet Extractor having an overflow drainage rather than the usual siphon type drainage (see Fig. 1). The tissues are placed in the modified Soxhlet Extractor, which is then filled with dehydrating fluid. A funnel placed in the extractor is used to carry the condensate to the bottom of the chamber to insure a continuous change in fluid throughout the depth of the extractor. The flask is filled approximately three-fourths full of dehydrating agent, and 80–100 g of calcium carbide (depending upon the moisture content of the dehydrating agent and tissues) is also added to insure a completely anhydrous condensate. A thermostatically controlled hot plate with a variable temperature control is used as the source of heat. Thus, as the dehydrant is refluxed, the condensate (anhydrous dehydrating agent) enters the bottom of the extracting chamber, circulates through the tissues, and finally spills out through the overflow drainage back down into the flask. The apparatus should be operated under a hood, or else a rubber hose should be attached to the top of the condenser to carry off the fumes.

This method offers several definite advantages. Dehydration is more complete. A flow of circulating fresh anhydrous dehydrant completely surrounds the tissues at all times. This is an important consideration, since incomplete dehydration is a frequent cause of shrinkage and hardening of tissues within paraffin blocks after they have been cut off and put away. If a gradually increasing concentration of the dehydrant is desired, one need only fill the extraction chamber with the desired starting concentration of dehydrant at the beginning of the procedure. This dehydrant then will be very gradually replaced by completely anhydrous dehydrating agent, giving the effect of transferring the tissues through a finely graded series of reagents.

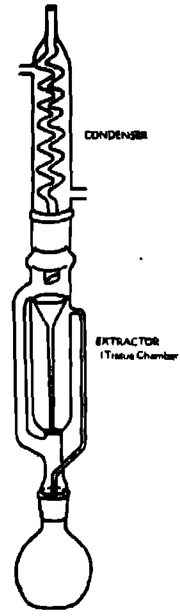

Fig. 1.

It is automatic. A manual transfer of the tissues is not necessary, nor is a manual change of dehydrating fluid. The tissues may be placed in the apparatus towards evening and left unattended until the following morning, when they will be dehydrated and ready for further processing.

It is inexpensive. Only small amounts of dehydrating agent are necessary, since the dehydrant is being continually refreshed as the process proceeds. The apparatus itself is of simple design, and any glass blower can make it at a nominal cost simply by altering a regular Soxhlet Extractor as indicated.

Although most of the commonly used dehydrating agents are adaptable to this procedure, it is preferable to use those having relatively low boiling points, so that the tissues may be safeguarded against any heat damage. We have had good success with acetone with the above method and at present are testing various other reagents, particularly those which can be used both for the dehydration and the clearing process, thus extending the automaticity of the procedure.

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[1] This work was supported in part by a National Institutes of Health grant.

Book Reviews

The chemistry and technology of enzymes. Henry Tauber. New York: John Wiley; London: Chapman & Hall, 1949. Pp. viii + 550. (Illustrated.) $7.50.

This volume is an expansion of the author's book *Enzyme technology*, published in 1943. The contents are divided into two parts: Part I, The Chemistry of Enzymes; Part II, The Technology of Enzymes. The addition of the fundamental material in Part I has increased materially the value of the book, and the inclusion of a number of the processes developed during the war has strengthened Part II. An occasional error such as *Streptococcus* for *Staphylococcus aureus*, while irritating to bacteriologists, in no manner detracts from the value of the work.

MALCOLM H. SOULE

University of Michigan

Elementary statistical analysis. S. S. Wilks. Princeton, N. J.: Princeton Univ. Press, 1948. Pp. xi + 284. $2.50.

This book is intended to be used as a text in a one-semester introductory course in statistics. While a knowledge of calculus is assumed, it is used only rarely: an acquaintance with elementary algebra will suffice for the reading of all but a few sections of the book, and those could be omitted without serious loss. It is clearly and lucidly written, and numerous examples are provided in the text to illustrate the principles brought out. The aim has been to make a few basic concepts entirely clear, rather than to cover a wide field.

The viewpoint is adopted which regards statistical analysis as a methodological tool of scientific research, rather than the traditional idea, still too common in elementary texts, that its main object is merely to give a summary description of a set of data. Thus, the role of probability is emphasized; and much attention is given to the problem of sampling, which is that of making inferences from a sample concerning the characteristics of the population from which it was drawn. It is refreshing to find that, by the introduction of confidence limits, the author has brought into his treatment of this subject a definiteness too often lacking in beginning textbooks.

THOMAS N. E. GREVILLE

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Public Health Service

Introduction to physics. (2nd. ed.) Harley Howe. New York-London: McGraw-Hill, 1948. Pp. xii + 599. (Illustrated.) $4.50.

This nontechnical book on physics is intended for students in the liberal arts, premedical courses, and agriculture. It embraces the usual classical subdivisions of the subject. Three chapters devoted to topics associated with modern physics are introduced before the final section on optics.

The author states in the preface that a knowledge of elementary algebra and plane geometry is sufficient mathematical background for an understanding of the text. This level is consistently maintained. There are few equations that cannot be understood from the principles elucidated here.

Some users of the book will want to supplement it with additional classroom material. This is particularly true of the section on rotational motion, which seems to be unnecessarily brief.

All in all, the book is a good one. It should prove an understandable and appropriate text for use in a course designed to fill the needs of the student who wants a fundamental course in physics to supplement his major study.

WALTER M. NIELSEN

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NEWS and Notes

Raymond E. Masters, of the Westinghouse Corporation's East Pittsburgh medical staff, has been appointed medical director of the corporation's recently formed Atomic Power Division at Bettis Field, near Pittsburgh.

Sam Granick, of the Rockefeller Institute for Medical Research, will deliver the eighth Harvey Lecture of the current series at the New York Academy of Medicine on May 19. His subject will be "Home and Chlorophyll."

Norbert Wiener, professor of mathematics, Massachusetts Institute of Technology, will speak on "Cybernetics" at the Howard University College of Medicine, Washington, D. C., May 12, at 8:30 p.m. The occasion is the second annual Howard University Sigma Xi lecture.

Visitors to U. S.

Gösta Elfving, of the University of Helsingfors, Sweden, has been appointed visiting professor of mathematical statistics for the academic years 1949–51 at Cornell University.

Corneille Heymans, professor of pharmacology of the University of Ghent, Belgium, is visiting professor of pharmacology at Emory University School of Medicine, Georgia, during the spring quarter.

Robert Broom, South African paleontologist, recently visited the University of California at Berkeley, where he lectured on the significance of man-apes in human ancestry.

E. Haegglund and **H. W. Giertz**, of the Cellulose Industriens Central Laboratorium, Stockholm, Sweden, will address the Symposium of Wood Chemistry, Polytechnic Institute of Brooklyn, New York, on May 7.

Fellowship

The University of Cincinnati has announced the establishment of a Texaco fellowship in industrial medicine. The grant will be for a two-year period starting July 1, and leads to the degree of doctor of industrial medicine. Candidates interested in this training opportunity may write to Robert A. Kehoe, Director, Institute of Industrial Health, University of Cincinnati.

Colleges and Universities

Two lectures are scheduled at the **University of Vermont** in Burlington. T. M. Sonneborn of the Department of Zoology, University of Indiana, will speak May 5 on the physical basis of cell transformation. On June 2, C. D. Rhoads, of the Memorial Hospital and Sloan-Kettering Institute for Cancer Research, will speak on the use of isotopes in cancer research and treatment.

The Montreal Neurological Institute of McGill University will hold its 14th Hughlings Jackson Memorial Lecture on May 13. The guest speaker will be H. Cuthbert Bazett, professor of physiology at the School of Medicine, University of Pennsylvania, who will speak on "Blood Temperature in Man and Its Control."

The University of Illinois' new $400,000 Aero Medical and Physical Environment Laboratory was officially occupied on April 11. The staff consists of A. C. Ivy, director; John P. Marbarger, research director; Victor Guillemin, Jr., biophysicist; and M. K. Fahnestock, engineering director. Research studies are planned on physical environmental factors in healthy and diseased human beings, and further studies in aviation medicine.

All Harvard University freshmen will take at least one course in General Education, beginning this fall, and by 1951 all undergraduate students will be required to take elementary courses in three fields of learning: the humanities, the social sciences, and the natural sciences. Most students will select these three courses from the 12 or more elementary courses offered in General Education. During his four years, each student must take at least six courses outside the department in which he is concentrating. To carry out the new program, Philippe Le Corbeiller has been appointed professor in General Education, and John Sawyer, I. Bernard Cohen, Gerald J. Holton, Daniel H. H. Ingalls, and Richard N. Frye have been appointed assistant professors.

Summer Programs

The Institute of Polymer Research and the Division of Applied Physics of the Polytechnic Institute of Brooklyn announce the sixth annual series of summer laboratory courses: Industrial Applications of X-Ray Diffraction, to be held June 6–17 (attendance limited to 20); Advanced X-Ray Diffraction, June 27–July 2 (attendance limited to 10); Molecular Weight Determination of Polymers, June 27–July 1 (attendance limited to 12); and Polymerization Techniques, July 25–29 (attendance limited to 12). Inquiries should be addressed to: Professor I. Fankuchen, Division of Applied Physics, Institute of Polymer Research, Polytechnic Institute of Brooklyn, 85 Livingston Street, Brooklyn 2, New York.

The American Oil Chemists' Society and the University of Illinois are sponsoring a course in the production and processing of edible fats, at Urbana, Illinois, August 15–19. Lectures will be held in the morning, symposia in the afternoon and evening. A preliminary outline of the program was published in the March *Journal of the American Oil Chemists' Society.*

The University of California Medical School announces a postgraduate course in the medical aspects of nuclear energy, August 29–September 3, at the Medical Center, San Francisco. Joseph G. Hamilton, director of the Crocker Laboratory, University of California, will be chairman of the course. A detailed program will be mailed upon request addressed to: Stacy R. Mettier, Head of Postgraduate Instruction, Medical Extension, University of California Medical Center, San Francisco 22.

Meetings and Elections

The American Society of Mechanical Engineers will hold its spring meeting in New London, Connecticut, May 2–4. Papers will be presented on nuclear energy, materials handling, power, production engineering, management, machine design, education, metals engineering, heat transfer, aviation, fuels, textiles, gas turbines, safety, process industries, and underwater craft, in a program of 20 technical sessions. Rear Admiral Fife, Commander of the Submarine Force, U. S. Atlantic Fleet, and James M. Todd, ASME president, will speak on "The Road to Peace" at the Tuesday evening banquet at the Mohican Hotel, headquarters for the meeting.

Emil Artin, of the Department of Mathematics, Princeton University, is presenting results of his investigations on the **Theory of Braids,** as a Sigma Xi national lecturer at the following institutions: May 5—Corning Glass Works, Corning, New York; May 6—University of Rochester, New York; May 11—University of Michigan, Ann Arbor; May 13—McGill University Montreal; May 17—University of Massachusetts, Amherst; May 18—Yale University, New Haven, Connecticut.

A Symposium on Fine Particles and Resolution will be held June 9–11, at the Stevens Hotel, Chicago, under the sponsorship of Armour Research Foundation of the Illinois Institute of Technology, and the Physics Department of the institute. The symposium will be composed of four sessions. The session topics and chairman are: "Light Scattering"—P. J. Debye, Cornell University; "Resolution"—C. W. Mason, Cornell University; "Formation and Size Distribution of Dispersoids"—H. F. Mark, Brooklyn Polytechnical Institute; and "Microscopy of Fine Particles"—Robley C. Williams, University of Michigan.

A group of experts will present formal papers or semiformal remarks at each session; Discussion will be directed by the session chairman. In addition to the regular sessions there will be instrument displays and a photographic exhibit including electron and light micrographs dealing with subjects that are related to the symposium topics.

The general chairmen for the symposium are W. C. McCrone and C. F. Tufts; further information may be had by writing them at the Armour Research Foundation of Illinois Institute of Technology, 35 West 33rd Street, Chicago 16.

Questions for general discussion at the sessions will be considered by the session chairmen if the questions are submitted in writing prior to the day the symposium convenes. Such questions should be addressed to the attention of the general chairmen. Persons wishing to participate in the photographic exhibit should submit their material before *June 6*. Prints should be sent to the attention of the general chairmen.

The symposium is an outgrowth of the highly successful Symposium on Electron and Light Microscopy (*Science*, June 4, 1948) which was held in Chicago last year and attended by more than 250 scientists.

The Pacific Division of the AAAS will hold its 30th annual meeting at the University of British Columbia, Vancouver, June 13–18. Registration will open Monday morning at 9:00. The first general session, to be held Monday afternoon, will be the divisional symposium on "Anthropology and Its Applications to Society." On Tuesday morning there will be a symposium, sponsored by the Pacific Science Board of the U. S. National Research Council on "Research Plans for the Pacific Area, with Special Reference to the Seventh Pacific Science Congress." L. S. Crossman, president of the Pacific Division, will speak on "Early Man in the Pacific Northwest" Tuesday evening. Nineteen associated or affiliated societies will participate in the meeting. G. M. Shrum is chairman of the Committee on Registration and Information. Inquiries may be addressed to him at the University of British Columbia, Department of Physics, Vancouver, B. C.

The United Nations Scientific Conference on the Conservation and Utilization of Resources will open its three-week session at Lake Success, New York, on August 17. This will be the United Nations' first step toward mobilizing science for the purpose of raising the world's standard of living. The UNSCCUR has asked 650 scientists to prepare papers on subjects ranging from projects for producing synthetic fuels to harnessing the wind for electric power.

The Roscoe B. Jackson Memorial Laboratory will commemorate its 20th anniversary this year. The theme of the commemoration will be "Twenty Years of Research at the Jackson Laboratory," and a series of papers will be given during the summer session in honor of C. C. Little, founder, and director since 1929. There will be a reunion of friends of the laboratory, students, summer investigators, and staff members August 18th to 21st. Since some records were lost in the fire of 1947, all persons who do not receive invitations and who wish to attend are asked to write to the Chairman, Jackson Laboratory 20th Commemoration, P. O. Box 78, Bar Harbor, Maine.

The Brazilian Society for the Advancement of Science (SBPC) has been established with headquarters in São Paulo and will publish *Ciência e Cultura* as its official periodical. The first annual meeting is planned for next October at Campinas, São Paulo. Correspondence should be addressed to the Sociedade Brasileira para o Progresso da Ciência, C. P. 2926, São Paulo, Brasil.

The American Committee for the Seventh International Congress for Cell Biology held a meeting at Philadelphia on April 13 to consider plans for the Congress which is to be held at Yale University September 4–8, 1950. The honorary chairman of the committee is R. G. Harrison of the Osborn Zoological Laboratory at Yale; the president of the congress is J. Runnstrom, of Sweden. A fund of $50,000 is planned, for use largely in bringing distinguished scientists to the U. S. to participate in the congress.

Deaths

Charles Taylor Vorhies, 69, head of the Department of Entomology and Economic Zoology, University of Arizona, died suddenly March 10 in Washington, D. C. while attending meetings of the National Wildlife Federation.

Willard H. Dow, 52, chemical engineer and president of the Dow Chemical Company, died March 31 in a plane crash at London, Ontario.

Sir Hugh S. Gladstone, 71, ornithologist and author of many books on bird life, died April 5 in Thornhill, Scotland.

Sydney Ball, 71, mining geologist and consulting mineralogist to the U. S. Bureau of Mines, died in New York City on April 8. In 1907 Mr. Ball headed an expedition that opened up one of the world's largest diamond mines in the Belgian Congo.

Eugene H. Pool, 74, consulting surgeon and former professor of clinical surgery at the Cornell University Medical College, died April 9. Dr. Pool had also served as president of the New York Academy of Medicine and the American College of Physicians and Surgeons.

The Economic Cooperation Administration has financed the purchase of $9,000,000 worth of streptomycin by Marshall Plan countries. It is also financing the acquisition of American equipment worth $500,000 for reconstructing two streptomycin-producing plants in France.

Life insurance companies of the United States and Canada will contribute $680,000 during the coming year for research in heart disease. Of this amount, $585,300 has been awarded as grants-in-aid to 35 universities and research centers. The remaining $94,700 was allocated for 27 research fellowships in the field of heart disease.

Make Plans for—

Symposium on Luminescence, sponsored by the Electronics Division, Electrochemical Society, May 5–7, Philadelphia, Pennsylvania.

Mathematical Association of America, annual meeting of the Indiana Section, May 7, University of Norte Dame, South Bend.

Indiana Academy of Science, annual meeting, May 13–14, Clifty Falls State Park, Madison.

A Background for Biological Studies with Radioiodine

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PEOPLE WHO MAKE HISTORY, it is said, do not have the time to read it. Nevertheless, a little perspective is a good thing in assessing the value of one's work and in indicating which experiments it is important to pursue. This is particularly true of thyroid physiology because of the rapid speed with which studies involving radioactive iodine have progressed. For instance, my monograph published in 1940 (*21*) includes this statement:

> *Radiation Therapy with Radioactive Iodine.* It has been suggested by a number of investigators that in thyroid hyperplasia and neoplasia it might be possible to treat the disease with iodine, which, being radioactive, would be trapped in the thyroid tissue and would disintegrate there close to the site of the proliferating cells. . . .

It is interesting that this pipe dream, which seemed on the edge of the fantastic at the turn of the present decade, is now rapidly coming true.

Correlation with the past. Anyone familiar with investigations in iodine over a period of years becomes impressed by the fact that often the left hand doth not know what the right hand doeth. An illustration is the discovery of iodine, nearly one hundred and forty years ago. During the Napoleonic Wars the emperor was short of nitre with which to make gun powder, and his government subsidized a lot of little people known as *salpetriers* whose business it was to produce saltpeter. This they made from potash and later from kelp or a seaweed which they called *le varech* in the French vernacular. In 1811, a little manufacturer named Courtois discovered (*6*) that there was something in the liquors derived from his seaweed ash which corroded the copper lining of the vats. Out of this industrial problem came the isolation of a purple substance which the eminent French chemist Gay-Lussac (*8*) called iodine, from the Greek word *ἰώδης* which means *violet-like.*

By 1820 the Swiss physician Coindet (*5*) had published his classic paper on "*Découverte d'un nouveau remède contre le goître.*" This remedy soon became so popular that in the French Midi legislation was passed prohibiting the indiscriminate use of the material. Everybody knew that iodine, which came from seaweed, was a remedy against goiter. Nevertheless, when Baumann (*1*) in 1895 published his classic paper "*Über das Normale Vorkommen von Jod im Thierkörper,*" he said, "*Als ich diese Beobachtung zuerst machte, glaubte ich an alles Andere eher, als dass Jod meiner Substanz angehöre*" (When first I made this observation, nothing was further from my mind, than that iodine was connected with my material).

Physical biology vs. biological physics. Speaking with nuclear physicists, biophysicists, clinicians, and various people associated through a common interest in radioiodine, one cannot help being impressed by the fact that a comprehensive view of the problem often would greatly assist their work. The physicist, for example, tends to imagine a human body built up of relays of electric bulbs, wire springs, and steel supports. He evolves theories about this imaginary robot which do not really fit the circumstances of flesh and blood. The clinician, on the other hand, is often just as remiss in his naive way of applying physical tools to a tracer problem. One of the important consequences of the symposia that are frequently held today on biological radioactivity is the opportunity they present for a meeting of minds reared under variegated disciplines.

Questions to be asked and answered. An important question that I hope will be brought out in modern investigations is the question of the sweet reasonableness of the results. In other words, how do the data newly presented harmonize with the old facts established by classical chemical methods? In a recent review (*24*) I have attempted to interpret in physiologic terms some of the data on radioactivity now in the literature. Unfortunately, a good many findings are entirely empiric and have no obvious physiologic meaning. In part this is due to the fact that the data on radioactivity have not been integrated with a supportive program of biochemical study. Furthermore, in part the data derived by isotope studies have been confused by technical problems.

This betrayal of the scientist by his armamentarium is no new problem. About 1850, for example, the French scientist Chatin developed a micromethod for measuring iodine. He applied it in a comprehensive study of the waters of the various valleys of the Rhone, the Seine, and other rivers of France. Out of this work he drew the surprisingly clear statement

(4) that the principal cause of goiter and cretinism was an insufficiency of iodine. Moreover, he went on to say that it would be a simple matter to reinforce the deficient sources of water supply with mineralized solutions of iodide (3). His fellow scientists tried to apply his method and failed. Finally, the French Academy surveyed these results and concluded that Chatin's work was not tenable. The poor man ended his career in disappointment and frustration; and the world remained indifferent to this important etiological factor in goiter until in rather recent decades the work of Marine (*14*), McClendon (*15*) and others eminently confirmed Chatin's hypothesis.

Similarly one finds today that, because of the inadequacy of biochemical and radioactive techniques, our modern scientists frequently disavow conclusions which are plainly true in the light of data established by the older classical methods.

The integration of older observations with modern findings. Chatin's contemporaries laid too much emphasis upon negative technical findings. In so doing they ignored a train of independent observations covering a span of 17 centuries. I can mention only a few of these. In the first century A.D., Pliny the Elder (*18*) noted that goiter occurred in certain localities and stated that the waters of these resembled the land. "*Tales sunt aquae quales terrae, per quas fluunt.*" In medieval times sponge had been used to treat goiter (*26*), and later had been incorporated in the "Coventry" treatment used in 18th century England (*27*). In Renaissance times Michelangelo (*16*) complained to his friend Giovanni da Pistoja that he had grown a goiter while painting in the Sistine Chapel—just as a cat in Lombardy might:

> I'ho già fatto un gozzo in questo stento,
> come fa l'acqua a' gatti in Lombardia,
> ovver d'altro paese che si sia,
> ch' a forza il ventre appicca sotto il mento.
>
> I've grown a goiter by dwelling in this den—
> As cats from stagnant streams in Lombardy,
> Or in what other land they hap to be—
> Which drives the belly close beneath the chin.

In 1812 Courtois (*6*) had discovered iodine in seaweed, and in 1809 the London Medical Dictionary (*17*) had recommended sea water to treat goiter. One wonders, now, how the leading French scientists dared to discredit Chatin's conclusions. Of course, hindsight is ever more lucid that foresight and it is all too easy to scoff in retrospect. As he picks up his beautiful new tool, however, it is well for the modern biologist to remind himself how subtly and completely a fascination for gadgets can betray sound sense.

Evaluation of tools and methods. Part of the difficulty lies in a misplaced confidence in one's technique, or perhaps a failure to appraise the limitations of methodology. Again, history supplies an illustration. In 1848, King (*10*) at Guy's Hospital in London had hypothecated the existence of an internal secretion derived from the thyroid:

> . . . we may one day be able to shew, that a particular material principle is slowly formed and partially kept in reserve; and that this principle is also supplementary when poured into the descending cava, to important subsequent functions in the course of circulation.

Moreover about 1883, the rival Swiss surgeons Kocher of Berne and Reverdin of Geneva had agreed (*11, 20*) that the more nearly complete their thyroidectomy, the worse for the patient ultimately. After Sir William Gull (*9*) had described the widespread tissue changes in human myxedema and Fox (*7*) and Mackenzie (*13*) had demonstrated the reversal of these changes by the feeding of thyroid, Baumann (*1*) showed that the essential substance "thyroidin" contained iodine. It should have been obvious that an iodine-containing hormone normally circulates in the blood stream. Nevertheless, as late as 1914 it was believed (*2*) that the normal plasma contained no iodine in organic combination. The discrepancy was resolved only after improved techniques had been devised. Similarly, in the present decade the earlier publications on radioactive iodine frequently constituted pharmacologic rather than physiologic endeavors; because too much carrier (inert) iodide accompanied the so-called "tracer." Therefore, we must endeavor to bring out the answer to the question: How do these data harmonize with the established knowledge of thyroid physiology and iodine metabolism already developed painstakingly by classical methods of biochemistry?

Newer knowledge. We must also ask what new concepts have evolved from the use of radioactive iodine that were not established earlier. Obviously this new tool—perhaps the most important scientific weapon since the discovery of the microscope—provides the opportunity for a kaleidoscopic or cinematographic picture of metabolic events. By making repeated observations in a single animal or man, one can obtain a picture which formerly would have required the sacrifice of whole series of test animals. Nevertheless, it is a little disappointing to find some modern isotope-minded physiologists content with developing a series of data and proclaiming conclusions which are already well established in the literature of thirty years ago. Granted that the older data were built of painstaking analyses on single animals and the composite picture which had to be drawn therefrom; yet the final concepts—the heart of the problem—often have already been resolved by older techniques.

This problem of rediscovering what was long since established is not new. In October 1863 the eminent French clinician Trousseau (*25*) inadvertently gave a patient with exophthalmic goiter some tincture of iodine when he meant to write tincture of digitalis on the prescription blank. He did this because he knew subconsciously that iodine was traditionally a bad drug for these people. When the patient returned to his office, however, she was much improved. Discovering his mistake, the physician changed to tincture of digitalis and the patient rapidly became worse. In short, before the time of the American War between the States it had been demonstrated clearly that iodine was a good remedy in hyperthyroidism. Nevertheless, when Henry Plummer (*19*) in the third decade of this century emphasized the use of iodine in such cases, the world hailed this as a novel approach. Circumstances change but the general pattern is the same. Men do over and over again what their predecessors did two generations ahead of them because the train of history is lost.

One of the most important things which the isotope technique can give us, besides localization of the material anatomically, is the indication of its rate of metabolic turnover. Such measurements, however, cannot be established through isotopes alone. In order to establish turnover rates it is usually necessary to have simultaneous measurements of both stable isotope and tracer. It is surprising how many physiologists, biochemists, and clinical investigators still rely solely on determining radioactivity, without supportive biochemical analyses of the classical type.

Combined chemical and physical approaches. There is a tendency in present-day tracer studies to rely on biophysical measurements alone, without accompanying chemical identification (either qualitative or quantitative) of the substance under observation. For instance, the thyroid gland normally contains iodine in three chemical forms; but rarely are they separated before measurements of radioactivity are made (*12*). Moreover, the fact is frequently overlooked that in order to interpret measurements of radioactivity, simultaneous measurements must be made of the inert iodine present. In other words, it is frequently necessary to know the *specific radioactivity* of the chemical substance or fraction under study. Consider the blood plasma of the normal rat, with a steady concentration of "hormonal" iodine H₀ at about 2.5 micrograms percent. If one is to estimate the turnover rate of this hormone by administering radioiodide, one must combine data on radioactivity with microchemical analyses because the hormonal concentration represents a dynamic equilibrium (*22*). As fast as a little new radioactive hormone is formed, part of it is metabolized together with the previously extant hormone. This relationship is represented by the equation

$$\frac{dH}{dt}\left(1-\frac{L}{H_0}\right)=\frac{dL}{dt},$$

where H is the newly formed hormone and L the labeled hormone unexpended. At any given moment L can be evaluated from measurements of A, the radioactivity observed, and from σ, the specific radioactivity of the body's reserve of iodide. As a first approximation, these can be described by the following equations:

$$\frac{-d \log \sigma}{dt} = k_1,$$

$$\frac{dL}{dt}=\frac{dA}{\sigma dt}=\frac{1}{K_0}\cdot e^{k_1 t}\frac{dA}{dt}.$$

Once L has been evaluated, the amount of newly made hormone can be calculated easily because

$$H_{t_0}=-2.5\,ln\left(1-\frac{L_{t_0}}{2.5}\right).$$

The ultimate solution for turnover rate, therefore, involves some sort of multiple integration. Without this mathematical approach much of the work which has appeared in the last few years cannot be interpreted physiologically (*23*). In general, for work with biological systems one cannot be content with isolated physical measurements presented on an empirical basis.

At this juncture, therefore, it is well to stop and think in terms of our accumulated knowledge of iodine metabolism and of thyroid physiology. Let us ferret out those new developments and new concepts for which the use of radioiodine is directly responsible. Let us inquire carefully into technical problems and means of solving them; but let us not be so diverted with gadgets that we forget the purposes which these tools might serve. Let us remember that biophysical methods must be adapted to the organism rather than the organism warped to fit oversimplified physical theory. If we bear these points in mind, we shall be able to bring out the answers to our chief questions, namely: 1) How has radioiodine improved our knowledge of iodine metabolism and of the physiology and the therapy of the thyroid? and 2) How do the results harmonize with past experience? If we understand clearly the answers to these questions it will be obvious what work must be done to make progress along modern biological lines.

Adapted from a paper presented at the Symposium on Radioiodine held at Brookhaven National Laboratory, Upton, New York during July 1948.

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Standardization of Radioactive Iodine

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THE TECHNIQUES AND INSTRUMENTATION of standardization that are to be described here are those available generally in laboratories equipped for work with radioactive materials in biology and medicine. Problems that can be solved by specialized and more complicated methods in a purely physical laboratory will be discussed only in a general way; however, such measurements as can and should be performed by every user of radioactive materials, especially I-131, will be presented in more detail.

The standardization of a physical object involves first of all a description of the measurement procedure and a definition of the unit to be used. The two are, however, not necessarily independent of each other; and we usually are free to select more than one procedure and unit.

Let us consider a piece of steel. We can standardize it by weighing, and the unit which we will assign to it by this procedure may be the kilogram. As is true of every good physical unit, there are several well-known measurement procedures for comparing our piece of steel to the physically permanent standard kilogram. The "weight" is an adequate standardization result if we want to use the piece of steel as ballast in a ship. Should we want it for casting, however, weight will not be the information required; we shall need its volume, expressed, let us say, in ml. To measure this directly is rather more complicated than weighing; we should not be permitted to use density, since "density" implies that a volume measurement and weighing have been performed on the identical steel at least once previously. If we plan to use the piece of steel as an armor plate, we shall need a different standardization, its thickness in cm, which can be easily measured by a micrometer. The situation will become more involved if we are to use the steel as a gamma-ray absorber. The micrometer, which gives the thickness in cm, will be very useful as long as we use the same steel alloy. But if we use different steel alloys, or even different materials, we find that the simple absorption equation is complicated by a coefficient that is characteristic for every material and varies widely. We know from our experience that the variation of this coefficient is reduced by at least one order of magnitude if we standardize the thickness of absorbing materials in g/cm^2 instead of cm. Such standardization involves more complicated measurements than the simple use of a micrometer. Yet this is what we do, for reasons familiar to us all.

The purpose of this example is to recall the multitude of possible standardizations on the same physical object and to show 1) how availability and simplicity of measurement procedures may determine the selection of units, and 2) that, depending on the ultimate use and application of the information supplied by standardization, one system of units may be exchanged for another, for simplicity and convenience.

In working with short-lived radioactive isotopes, a gravimetric unit for standardization is practically impossible. One hundred μg of I-131, the smallest amount that can be weighed with reasonable precision, has, after filtration of beta radiation, a gamma radiation equal in ionization to about 15 g of radium. Such large amounts were undreamed of only a few years ago, and their handling is too hazardous for routine procedures. We had to work with very minute quantities, which could be detected and measured with the G-M tube.

The G-M tube indicates single radiation events associated with nuclear disintegrations. It seems natural, therefore, that, at a time when only small quantities of radioactive isotopes were available, most easily detected and measured by the G-M tube, a unit based on the disintegration rate was proposed and came into general use. This unit was derived from the curie—the amount of any nuclide of the radium family in secular equilibrium with 1 g of radium. It is hence derived from a gravimetric unit.

In selecting a disintegration rate unit for radioactive isotopes, it appeared natural at first to tie it in with radium measurements and to use as the unit a disintegration rate equal to the disintegration rate of one curie of radium. The disintegration rate of radium, however, is not known to better than about ½% accuracy. A number close to the experimental value was chosen, therefore, and was used in the definition: 1 millicurie of a radioactive isotope is the amount in which, at the time of measurement, 37 million disintegrations occur per second.

One of the objections raised against the use of the disintegration rate mc was the possibility of confusion with the radium mc. Condon and Curtiss have proposed the rutherford (rd), defined as 1 million disintegrations per second. I do not feel that the possibility of confusion is sufficiently serious to warrant the introduction of a new name and unit. Any standardization result always reads: "*x* units of *y* isotope." Whenever *y* is not radium, we know that disintegration rate is meant. It is scarcely worth while to differentiate the disintegration rate mc by a prefix as "isotope mc." The numerical simplicity of the "rutherford" is an even slighter advantage.

After this lengthy introduction we can approach our proper subject: standardization of radioiodine. Before we discuss how we can use the mc unit, let us look at Fig. 1, summarizing the results of standardizations performed in 70 different laboratories in this country on samples of equal content of I-131 (third intercomparison by the National Bureau of Standards). This offers quite a dismal picture. The standard deviation is about 30%; the range is from 43 to 180, about 1:4, almost an order of magnitude.

Obviously, standardization is not a simple procedure. Yet it is an extremely important one. If a worker at the upper end of the frequency plot reports a certain dosage for treatment of a given disease, and a worker at the lower end makes use of this dosage information, he will give four times the effective dose, will possibly exceed the therapeutic latitude, and will get deleterious results (permanent hypothyroidism, for instance, in treatment of Graves' disease).

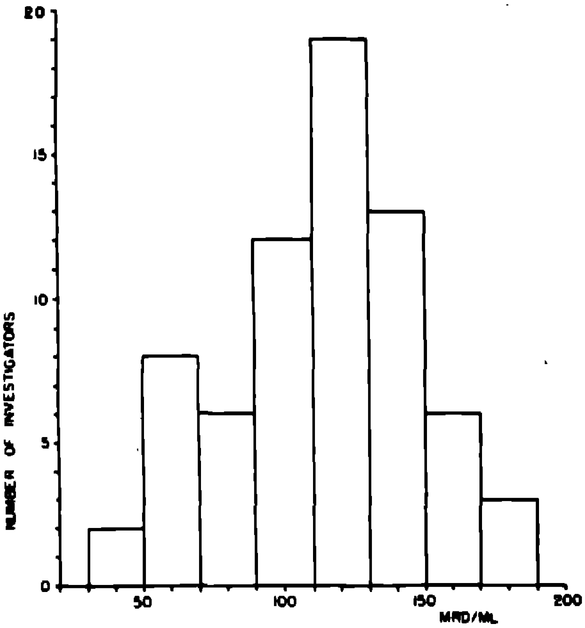

FIG. 1. Frequency distribution plot of standardization results by 70 laboratories (third intercomparison conducted by the National Bureau of Standards).

We can make some fairly good guesses at the reasons for this wide spread.

There are actually several factors involved, and for purposes of discussion we may differentiate three groups among the 70 laboratories: 1) those making their own primary measurements; 2) those comparing the counts from a standardization sample of a long-lived radioactive isotope with the counts from the I-131 sample to be standardized; and 3) those calibrating their measurement equipment with a sample of I-131 standardized by a laboratory of group 1 or 2.

The spread of the NBS intercomparison is obviously due to the discrepancies in the determinations of groups 1 and 2, on which are superimposed the errors of group 3. The discrepancies in the results of the workers in group 1 mirror the actual difficulties of absolute standardization in millicuries. Theoretically, the best and apparently the most direct method of disintegration rate determination is that of coincidence counting. However, this has the serious disadvantage that its correct use presupposes knowledge of the exact disintegration scheme. The disintegration scheme of I–131 that we had formerly assumed to be correct is now in doubt. This uncertainty makes the results of coincidence measurements doubtful.

A second method of absolute standardization in mc is based on the ionization produced by gamma radiation of I–131. If the old disintegration scheme were correct, and we could assume no internal conversion of the 80-kev photons, a 1-mc-sample of I–131 would produce 0.265 mr per hr at 1 m in air. The new disintegration scheme, accepting an incidence of a 650-kev gamma-ray transition, would increase this figure by at least 5%; and it would affect the results of coincidence measurements to an even higher degree.

The difference between NBS and Oak Ridge (coincidence measurements) on one hand, and the Memorial Hospital values (gamma ionization) on the other hand is at present about 20%. When the uncertainty in the disintegration scheme is overcome, we may expect this difference to disappear.

I shall not discuss the technical details of the absolute standardizations just described because they are normally beyond the scope of laboratories with a biological orientation. But I want to emphasize that we have encountered what I believe to be one fundamental difficulty involved in the use of the mc unit: in order to use it in the standardization of an isotope sample we need a considerable amount of information about the isotope's nuclear behavior, which we do not have for most isotopes.

Workers of group 2 have new difficulties, due to the different energies of the radiations of the long-lived reference standard and of I–131. The beta energy of RaD + E standard, for instance, is much higher than the beta energy of I–131. This brings about not only an increased error in the extrapolation for zero absorber, but introduces errors due to the difference in counter efficiency at different energies, and also differences in scattering. All this necessitates complicated corrections, with the possibility of a considerable cumulative error.

There is, at least theoretically, a solution for the method of group 2: the preparation of a long-lived isotope standard with a radiation of type and energy close to that of I–131. A 3.5-year-half-life isotope of thalium (Tl–206) disintegrates by beta emission of 0.87 Mev, which is close to the I–131 beta energy of 0.687 Mev. I–131 samples, compared with such a standard using suitable filters for gamma background correction, may give values requiring only small correction factors for the characteristics of the G-M tube and the material and geometry of the shelf setup. The ideal solution would be a mixture of long-lived isotopes, all of which have the same half-life, and which emit beta- and gamma-rays iso-energetic with I–131; however, such a mixture does not appear feasible.

An essential advantage of group 2 methods, apart from the difficulties and uncertainties which have been discussed, is the availability of a permanent reference standard which insures against short or long term fluctuations in the sensitivity of measuring equipment and against losing the calibration when replacing or changing such equipment.

We come now to group 3, which is our proper domain: standardization by use of instruments calibrated against a "known" I–131 sample. We have to keep in mind, of course, the errors and uncertainties in the measurements of group 1 or 2, who have supplied the sample.

As a first example, we may take the simplest situation which occurs in tracer work: we want to measure the excretion of I–131 after oral administration of a tracer dose. We will keep an aliquot of the administered solution as reference sample, and measure the excretion in urine against the known standard. This will not only eliminate automatically the decay factor, but it will also take care of long term instability of our G-M setup. There will be one very important precaution to be observed: there must be complete identity in the preparation and handling, and in the physical and geometrical counting setups of the reference standard and the measured sample. If we use dried samples in order to obtain maximum sensitivity, we risk variations not only in self-absorption but also in loss of I–131 from the two samples, due to differences in drying, pH, etc., between the standard and the urine samples. Loss of iodine is a serious source of error in working with dried samples. I suspect, for instance, that the lower values in Fig. 1 (intercomparison by the National Bureau of Standards) is due to the use of dried samples with the concomitant loss of active material.

It is simpler to eliminate this error by the use of liquid samples. G-M tube setups with adequate sensitivity have been devised for this work—concentric gamma counters (Marinelli), and mixed beta and gamma counting, using liquid samples with thin glass wall cylindrical G-M tubes or with bell type counters of sufficiently large diameter. When using liquid samples, the danger of losing some iodine is reduced, but not eliminated. Here the main factor is pH. In the preparation of samples from the alkaline I–131 solution supplied by Oak Ridge, we found it best to dilute with distilled water only, checking with indicator paper.

The usefulness of a known standardized I–131 sample for direct comparison ends in a few weeks because of radioactive decay. We might attempt to maintain the direct comparison method by preparing a secondary, tertiary, etc., I-131 standard sample. But the errors will accumulate and in a few months we would expect a considerable drift from the original standard. We would, therefore, prefer to obtain a *permanent calibration* of our equipment on the basis of the original known sample. But the G-M tubes, which we hold in such a high esteem because of their sensitivity, are rather unreliable as far as the permanence of their calibration goes. Their counting efficiency is subject to many fluctuations, due to such factors as temperature, air pressure, and aging. To some extent, these fluctuations can be taken into account by frequent check (several times daily) against a radium source.

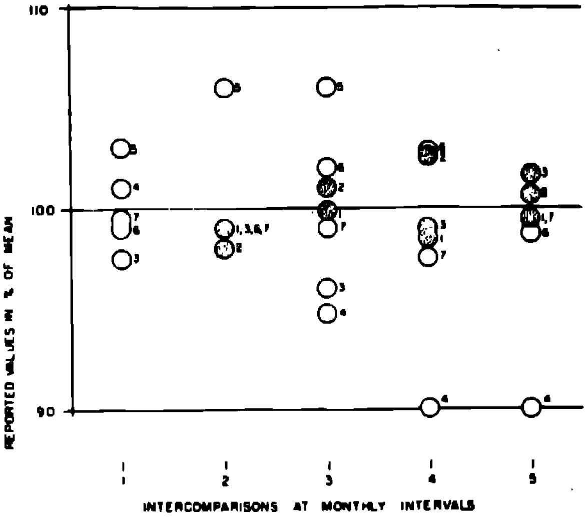

FIG. 2. Results of standardization by seven New York laboratories. Plain circles, G-M tube measurements; stippled circles, ionization chamber measurements.

When using such radium check, several points must be considered. Radium buttons of luminescent paint are unreliable because of the erratic loss of radon. Glass ampules with radium chloride solution, supplied by the NBS are adequate, but they are inconvenient to handle, and fragile. I have prepared sources with a few micrograms of radium by sealing radium paint in glass tubes and mounting the tubes in metal containers ¼ inch in diameter and 1 inch long. They are convenient to handle, since it is easy to place them in a reproducible position with respect to the counter by drilling a ¼-inch hole somewhere in the counter setup. The sources have proved satisfactory in our own and in two other laboratories.

The use of a radium check improves the constancy of the G-M tube calibration, but does not make it perfect or permanent; there is no reason to assume that the counting efficiency ratio of the G-M tube between the hard gamma radiation of radium and the softer gamma radiation and beta radiation of I-131 remains constant throughout the useful tube life. Using a radium check, one may expect a steady drift of the calibration. The use of a radium sample as a check is therefore an improvement, especially for short periods; but it is not a final solution. When a G-M tube is replaced, even by the same type of the same manufacturer, a new calibration against a "fresh" known I-131 sample is required.

Fig. 2 illustrates the degree of consistency in standardization practice that can be achieved between several independent laboratories using this method of calibrating equipment against a known sample.

Seven laboratories in New York City[1] have conducted monthly intercomparisons during the last five months. The radioiodine samples used in the original calibrations were standardized by the Memorial Hospital. In the third NBS intercomparison, we were all on the main peak of the frequency distribution plot (Fig. 1) and had a standard deviation of 3.5% among the seven laboratories. In Fig. 2, summarizing our local intercomparisons, the open circles represent G-M counting measurements. After the second intercomparison, Memorial Hospital corrected absorption extrapolations, and is now 10% below the mean based on the original Memorial values. The standardization results are within 5% of the mean. I believe, however, that without future recalibration these G-M values will drift apart.

I feel convinced that the solution of our problem is the replacement of the highly sensitive and somewhat temperamental G-M tube by a less sensitive but more rugged and reliable instrument for purposes of standardization, such as the ionization chamber.

The required sensitivity is dictated today, not by the available amounts of once scarce isotopes, but by health hazards in handling. Since it is relatively safe to handle a few hundred μc of I-131, the great sensitivity of the G-M tube is not required. The sensitivity of an ordinary thimble chamber, however, is not great enough.

Carl B. Braestrup has designed an ionization chamber of suitable sensitivity for use with I-131, which is illustrated in Fig. 3. This chamber can be used with any conventional electrometer of the Victoreen type. The I-131 sample is introduced into the chamber enclosed in a glass test tube. Correction factors for difference in volume of the sample are less than ½% up to 6 ml. The sensitivity is such that about 400 μc of

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[1] Columbia University, Radiological Research Laboratory, G. Failla (ionization measurements) and E. Quimby (G-M counting); Memorial Hospital and Sloan Kettering Institute, L. Marinelli; Montefiore Hospital, E. Oshry; Mount Sinai Hospital, S. Feitelberg; New York City Department of Hospitals, C. B. Braestrup; Veterans Administration Hospital, R. Yallow.

I-131 give the optimal discharge of 3/5ths of the Victoreen scale in 10 min.

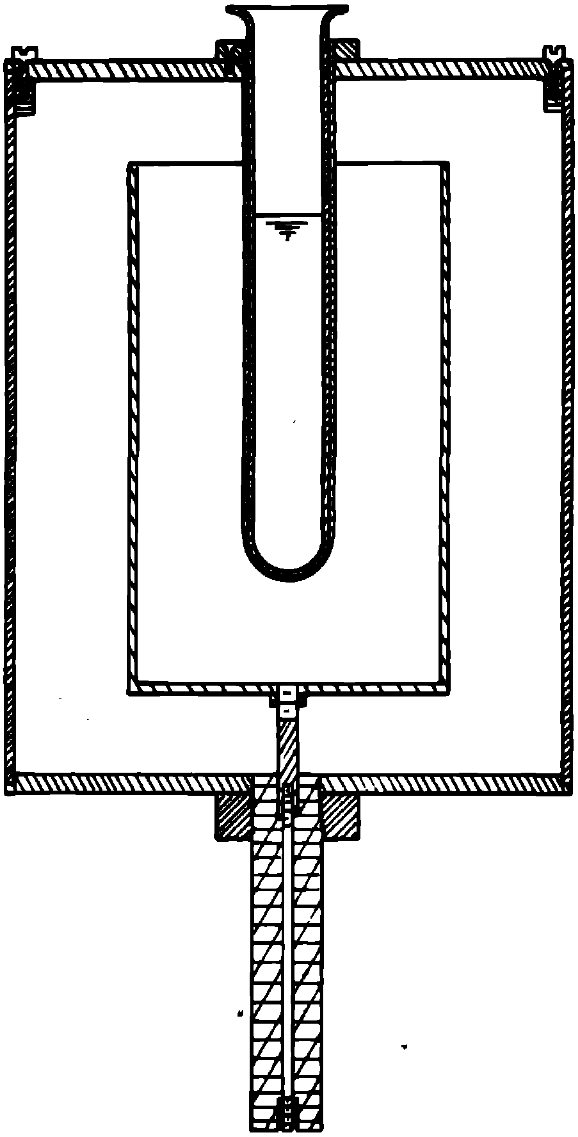

FIG. 3. Ionization chamber for gamma emitting isotopes, designed by Carl B. Braestrup. The chamber is made of brass, outside diameter 4 inches.

Another type of ionization chamber instrument has been designed by Failla; among other advantages it can also be used with pure beta emitters. However, it is rather expensive and not yet available commercially.

The essential advantage of ionization chambers is their simplicity, ruggedness and reproducibility. Once a Braestrup or Failla chamber is calibrated against a known radioiodine sample, it can be relied upon to give reproducible readings. Now the electrometer becomes the course of uncertainty, but we can eliminate this factor by checking against a radium source of 100 to 200 µg, which incidentally also compensates for variations due to air pressure and temperature changes.

The stippled circles in Fig. 2 are results of ionization chamber standardizations. They are within 3% of the mean. Radium checks, which have not been used yet for these measurements, may improve the consistency even further.

What precision in standardization do we need in biological work? The answer lies in the biological factors involved. For instance, the biological information for calculating dosage to the thyroid gland has a probable error of the order of 30%. We certainly do not want to have a physical error of similar magnitude superimposed on this. However, it would be unreasonable to require the errors in the standardization measurements to be less than an order of magnitude below the errors in the estimate of the biological factors. This means that we want the standardizations to be reliable within 3 to 5%, about what we expect in standardization of an X-ray machine.

If I may refer again to the intercomparison work of the New York laboratories, it appears that this precision can be achieved without undue difficulty, particularly when using ionization chambers. However, this pertains to relative and not to absolute measurements. We certainly do not believe that our New York mc comes within 5% of 37 million disintegrations per sec.

What is the ultimate purpose of the standardization information? It is two-fold: 1) to obtain a common denominator among all the workers, so that the experience of one group can be used by others, and so that the experience of all can be pooled in order to arrive at an empirically determined dosage; 2) to link the experience of internal radiation using radioiodine with the employment of other modalities of radiation therapy.

The present state of the art permits the accomplishment of the first purpose. I believe that one of the national agencies concerned with this work should initiate on a national scale a project similar to that undertaken by the New York laboratories at city level. In addition to supplying uniform standardized samples at regular intervals, such a project would also make available critique and advice on standardization practice to workers who find difficulties in achieving reproducible results. For this purpose it is irrelevant what I-131 mc unit is used. It should be possible, within a few months, to reduce the national spread to a standard deviation of at most 5%. We in New York will shift from our somewhat arbitrary but, we believe, consistent and reproducible "New York mc" to any value on which there is such national agreement.

The second purpose is linked with absolute measurements. An arbitrary mc dose does not permit us to use with confidence the factors necessary for calculating energy absorption in tissue (rep). Discrepancies in primary absolute measurements are considerable. We may have to wait until these discrepancies are resolved, and until the disintegration scheme of I-131 is thoroughly established. However, there is another solution. We could take, for instance, the New York mc and measure the energy emitted for such a unit of I-131. If such measurements were available (I believe that they are being made at present), we could calculate dosage in roentgen equivalents, and the mc with its inherent uncertainty would cancel out.

In this connection, I would like to recall to you Failla's suggestion for a unit of radioactive isotopes, which he calls "ruth," for Rutherford: one ruth is the amount of any radioactive isotope that emits ionizing radiation at the rate of one erg per sec. Since I believe that the ionization chamber will replace the G-M tube as a standardization instrument, it seems to me that the disintegration rate unit will lose its usefulness. It is not very practical to use a unit which implies disintegration rate measurements if the actual standardization practice measures the amount of ionization and does not count the number of ionizing events. But this is not the opportunity to recapitulate Failla's arguments, with which I personally agree. The main advantage of the ruth, I think, is that a unit based on energy emission furnishes more directly the information which we, as consumers of atomic energy, ultimately require.

I have attempted to present the material necessary for the evaluation of standardization procedures and for the accomplishment of reproducible comparison measurements. Our main effort in standardization work should be directed toward a uniform standardization, although this may be for the time being on the basis of a standard which is to some extent arbitrary. All of us can contribute to this limited objective.

The question of absolute standardization is the domain of a smaller group. The majority of us will have to wait for their results. But I hope that I may speak for this majority if I define what kind of result we need from absolute measurements: it is a result that will permit us to compute energy absorption of ionizing radiations of radioactive iodine in tissue.

Based on a paper presented at the Symposium on Radioactive Iodine held at Brookhaven National Laboratory, Upton, New York in July 1948.

Interstellar Polarization, Galactic Magnetic Fields, and Ferromagnetism

Lyman Spitzer, Jr., and John W. Tukey[1]

Princeton University

OBSERVATIONS by W. A. Hiltner (*5*, *6*) and J. S. Hall (*4*) indicate that starlight becomes plane polarized in its passage through interstellar space. The effect increases with increasing distance, and according to Hall's data amounts to about 5 percent ($= e^{0.05}$) difference in intensity between the two plane-polarized components for a star whose color excess is 0.50 magnitude. Since the color excess is known to be about one-ninth the total absorption (which thus amounts to $(2.512)^{-4.5} = e^{-4.1}$ for such a star), the absorption must vary by somewhat more than one percent with the plane of polarization.

Such polarizing absorption would exist if needle-shaped particles, of dimensions comparable with a wavelength of visible light, were present in interstellar space, and were oriented by some force. The ratio of the scattering cross sections of such needles for the two planes of polarization would be appreciable; according to the theory by R. Gans (*3*), for a small prolate spheroid with a length twice its diameter, this ratio is 2.74 if the refractive index in the spheroid equals 2.5. Thus a relatively small number of needles could produce the observed effect.

Two difficulties seem to stand in the way of this explanation: the origin of the needles and their orientation. If we accept as a working hypothesis: (1) the existence of small ferromagnetic particles, which, existing as individual domains, are intensely magnetic; and (2) the existence of magnetic fields in interstellar space with systematic components as great as 10^{-5} gauss; then these difficulties disappear. The first of these suppositions appears reasonable from an extension of the theory of J. Oort and H. C. van de Hulst (*8*) on the origin and growth of interstellar grains, while the fields proposed are of the order of those recently postulated by E. Fermi (*2*) in his theory of the origin of cosmic rays.

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[1] The authors are indebted to Drs. John Turkevitch, John Wheeler, and Eugene P. Wigner for generous and helpful comments.

According to Oort and van de Hulst, the interstellar grains grow by the accretion of atoms and evaporate on mutual impact when two clouds collide. Differences between the different molecules within a grain are not considered in the original form of this theory, but in most collisions the more volatile components must evaporate preferentially, thus concentrating the heavier atoms.

The relative numbers of different atoms other than H inside the grain may be taken as: O—100, C—40, N—40, Fe—10, Si—8, Mg—6, S—6, and others—$\frac{1}{2}$ or less. Most of these elements will be chemically bound with H, which is overwhelmingly the most abundant element in interstellar space, or with O. Thus when the grain is heated, most of these elements will go off as volatile hydrogen or oxygen compounds, leaving primarily Fe and Mg atoms and oxides, and some SiO_2, some Si going off as SiH_4. It is uncertain whether Fe and Mg will be left in the metallic phase, since they may be expected to form oxides by interaction with O or with H_2O before these are lost by evaporation. FeO seems less likely than Fe_3O_4 or Fe_2O_3, in view of the high relative abundance of O. Fe_3O_4 is a well-known ferromagnetic substance, and Fe_2O_3, when precipitated from a water solution, tends to form cubic crystals which are ferromagnetic.[2] Magnesium iron spinel, $MgFe_2O_4$, is also known to be ferromagnetic (*9*). Thus, the production of ferromagnetic grains by this process seems likely.

Theory and observation (*1, 7*) both indicate that small ferromagnetic particles, of radius about 10^{-6} cm or less, form single domains, uniformly magnetized. For somewhat larger particles the information is less definite, but it would appear that ferromagnetic particles of radius 2×10^{-5} cm are likely also to constitute single domains.[3] Furthermore, it is likely that an appreciable number of such particles would stick together on impact and form elongated particles, since the mutual energy involved vastly exceeds the thermal energy. For nearly spherical grains the parallel, end-to-end orientation provides much the larger interaction energy, and is therefore more probable.

Next we consider the orientation of such grains. The energy of orientation of a grain in a magnetic field of strength H is about HIV, where the volume V may be taken as 2×10^{-14} cm^3 for a cylinder 1.5×10^{-5} cm in radius and 3×10^{-5} cm in length. The intensity of magnetization I is about 10^3 gauss in a ferromagnetic domain. With H equal to 10^{-5} gauss, this orientation energy is 2×10^{-16} ergs, as compared with a value of about 10^{-15} ergs for kT at 10° absolute, a not unreasonable value inside a dense obscuring cloud. While Fermi's assumed magnetic fields would have different values in different clouds, the average number of clouds in the line of sight to a star 500 parsecs away is only 3 to 4, and the average net $|H|$ perpendicular to the line of sight should be about $\frac{1}{3}$ the rms H.

It is evident that production and partial orientation of ferromagnetic grains in interstellar space is at least consistent with present astrophysical theory. Since the indices of refraction for pure Fe_2O_3, MgO, and $MgFe_2O_4$ are about 3, 1.7, and 2.3, respectively, such particles would scatter light more effectively than the conventional ice particles discussed by Oort and van de Hulst. Thus the ratio of the number of oriented ferromagnetic needles to the number of unoriented grains of comparable size need be only a small fraction of a percent to explain the polarization observations. Obviously, further observations are needed, and much theoretical work remains to be done, both on the chemistry of the fusion process, and on the subsequent magnetic and optical properties of the resultant grains, before the suggestions presented here can be regarded as more than a working hypothesis. If additional research confirms the present picture, it may become possible to obtain direct experimental evidence on the magnitudes and directions of magnetic fields in interstellar space.

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[2] We are indebted to Dr. L. W. McKeehan for this information.

[3] We are indebted to Dr. C. Kittel for this information.

TECHNICAL PAPERS

Effect of Swine Influenza Virus on the Viscosity of the Egg-white Inhibitor of Hemagglutination[1]

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Egg-white (EW) contains a component which is capable of combining with influenza virus and inhibiting the agglutinative reaction of virus with *RBC* (*3, 5–6*). Furthermore, untreated purified swine influenza virus is capable of destroying the EW inhibitor, but suitably heated virus is essentially devoid of such destructive capacity (7). Thus far, the destruction of inhibitor by virus, which has aspects of an enzymatic action, has been inferred only from indirect experiments based on the hemagglutination phenomenon. Recently, it has been observed, as described briefly in the present report, that virus exerts a profound effect on the viscosity of solutions of semipurified EW inhibitor.

Semipurified inhibitor preparations were obtained from EW by repeated precipitation at pH 5.7 and extraction of the precipitate with 0.06 M phosphate buffer at pH 7.2 (*8*). Typical extracts, which were 40 to 60 times as active as EW on a nitrogen basis, contained 25 to 150 γ N and 50 to 125 γ carbohydrate[2] per ml; one preparation, A178 PIII EI, which was 41 times as active as EW, contained 150 γ N per ml and 12.5% N on the basis of dry weight. The inhibitor was nondialyzable and gave qualitative tests for protein. The swine influenza virus was a freshly purified preparation, obtained as previously described (*10*), containing 400 γ N per ml and characterized by a 50% endpoint infectious unit of $10^{-14.4}$ g N. The viscosity experiments were carried out in capillary viscometers (*9*) at 29.78° C.

The relative viscosity of preparation A178 PIII EI was found to be linear with respect to concentration over the range from 0 to 150 γ N per ml and had the value 1.255 at 100 γ N per ml. Assuming a density of 1.33 for the viscous component of this preparation, one may calculate a minimal viscosity increment (*4*) of approximately 400, a value considerably greater than that which is obtained with ordinary proteins (*4*). From this result one may infer the presence of a highly asymmetric component.

The effect of untreated, purified swine influenza virus on the viscosity of inhibitor solutions is shown in Fig. 1. The rate of decrease in viscosity is initially rapid, falling to a low value within a few minutes. The terminal viscosity (after 24 hr) of virus inhibitor mixtures was approximately 1.01, corresponding to a reduction of 80 to 90% in the specific viscosity (relative viscosity −1). This terminal value was essentially independent of the initial virus concentration.

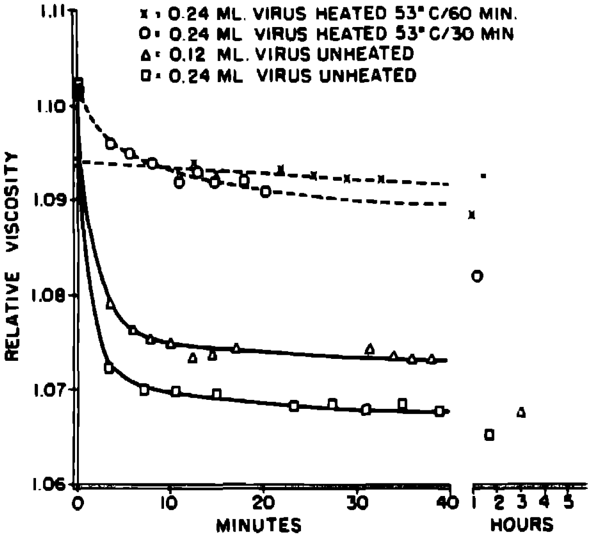

FIG. 1. Effect of heated and unheated purified swine influenza virus on the viscosity of solutions of purified EW inhibitor. The virus preparation contained 200 γ N per ml (2.2 mg virus per ml). The volume of virus preparation indicated in the chart was added to 10 ml of the inhibitor preparation A180 PEI containing 80 γ N per ml.

In an experiment of a different sort, 0.24 ml virus at a concentration of 200 γ N, or 2,200 γ virus per ml, was mixed with 10 ml inhibitor solution containing 30 γ N per ml with a relative viscosity of 1.0815, and the reaction was followed in the viscometer. After 25 min, when the relative viscosity was 1.0685 and was changing slowly, 5 ml reaction mixture was mixed with 5 ml fresh inhibitor solution. This process was repeated three more times. With each addition of fresh inhibitor there occurred a burst of activity as manifested in a rapid initial fall in viscosity. While it is difficult to interpret the results precisely at the present time, the experiment gave no evidence of saturation of the viscosity reducing capacity of the virus preparation. The activity of the fresh inhibitor solution was such that a quantity of 10 ml would have been capable of inhibiting the hemagglutinating activity of approximately 30 mg of virus heated 30 min at 53° C in concentration of 1 γ N per ml.

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[1] This work was aided by a grant to Duke University from Lederle Laboratories Inc., Pearl River, N. Y., and by the Dorothy Beard Research Fund.

[2] Determined with the orcinol reagent and calculated as glucose.

Fig. 1 shows also that heating the purified virus preparation for different periods at 53° C progressively reduces the capacity of the virus to cause a decrease in viscosity. These results with heated virus have a correlate in the reduction of the inhibitor destroying capacity of virus consequent to heating (*7*).

Studies of the effect of convalescent antiswine influenza swine serum showed that a quantity of serum capable of neutralizing completely the hemagglutinative activity of the virus prevented completely the typical effect of virus on inhibitor viscosity. The same amount of normal swine serum was somewhat less effective. The dependence of the rate of viscosity reduction on virus concentration and on the state of the virus, i.e., whether the virus was heated or not heated, as well as the absence of viscosity changes in the presence of immune serum, suggests that the reduction in viscosity is related to an interaction of the virus particles themselves with the viscous component of inhibitor solutions.

There are several reasons for supposing that the relationship of the EW inhibitor of hemagglutination to the viscous component of solutions of purified inhibitor is one of identity: (a) both the inhibitor and the viscous component appear capable of interacting with virus; (b) both suffer a change when treated with unheated virus, and both are less susceptible to action by heated virus; (c) the viscous component has probably a high molecular weight, and it is likely that any material of high molecular weight which is capable of combining with virus would be capable also of inhibiting virus hemagglutination; and (d) the specific viscosity of the two purified inhibitor preparations, A178 PIII EI and A180 PEI, which have been studied in detail, is proportional to the inhibitory activity. Calculated on a nitrogen basis, the activities of these preparations were 41 and 60 times, respectively, that of EW, and the specific viscosities at 30 γ N per ml were 0.075 and 0.105. This proportionality becomes a valid test when it is considered that the viscosity of purified inhibitor solutions is contributed chiefly by a component (or components) which is susceptible to virus action, as inferred from the low terminal viscosities of virus inhibitor mixtures.

The reduction in viscosity induced by virus may be interpreted as a reduction in the asymmetry of the molecules (or particles) susceptible to virus action. There are several obvious and quite different ways by which such a change in shape could be achieved: (a) the molecules could be fragmented across the long axis; (b) they could be made to fold or coil without change in size; (c) they could be made to condense with one another with simultaneous increase in size and decrease in asymmetry; and (d) they could form suitable stable complexes with virus particles. Of these ways, the first three could be thought to depend on an enzymatic action of the virus, while the fourth could be regarded as a process of stable aggregation of inhibitor molecules and virus particles. Support for the latter explanation is provided by the observation (*6*) that a precipitate forms at interfaces between EW and purified virus preparations. No definite evidence of precipitation has been obtained, however, in the present experiments with dilute solutions of purified inhibitor; and since inhibitor virus mixtures which have been incubated for long periods possess considerable hemagglutinative activity, comparable to that of uninhibited virus, it is likely that the virus separates from the viscous component after interaction. Accordingly, an enzymatic hypothesis of virus function offers the most reasonable explanation at the present time of the virus induced reduction in viscosity of solutions of purified inhibitor. This hypothesis is compatible also with the relative independence of the terminal viscosity on initial virus concentration and with the failure of repeated additions of fresh inhibitor solution to affect appreciably the viscosity reducing capacity of virus.

If the above interpretation is correct, the present observations provide the most direct demonstration, so far as we are aware, of an enzymatic action of influenza virus on a relatively pure and simple substrate. It should be mentioned that several previous attempts (*1, 2*) at such a direct demonstration have failed.[3]

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A New Human Hereditary Blood Property (Cellano) Present in 99.8% of all Bloods

Philip Levine, May Backer, Milton Wigod, and Ruth Ponder

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A new agglutinogen of human blood was recently observed with the aid of an immune agglutinin produced by a mother of an infant with a mild form of hemolytic disease.[1] This antibody, which behaves like a ''warm'' agglutinin (*4*), is remarkable because of the unusually

[1] The diagnosis was made by Dr. Eric Ponder on the basis of clinical and hematologic studies.

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[3] While this paper was in press, D. W. Wooley (*J. exp. Med.*, 1949, **89**, 11) reported changes in the viscosity of erythrocyte extracts on treatment with influenza virus A (PR8 strain).

high incidence of positive reactions (99.8%) in tests of 2500 blood specimens submitted for Rh testing. When first studied in May 1947, its titer at 37° C, in saline, was 1:64 and 18 months later its activity was only slightly diminished (1:32). Its titer was 1:1 at 20° C and 1:4 at 5° C. Absorption experiments with numerous blood specimens of different antigenic structure indicate that the high incidence of positive reactions is attributable to the action of a single antibody.

For want of a better name, this blood factor will be referred to by the patient's name, "Cellano", and its antibody as "anti-Cellano."

Of the 2500 blood specimens tested with anti-Cellano, more than 90% were from women whose Rh negative blood was submitted for antibody determination. Excluding the blood of the immunized mother, only five were found to lack the Cellano factor (0.2%). The antigenic structure in these five and in the patient's blood is given below:

			Reactions with Anti-				
			D	C	E	c	
1. Patient Cellano	A	N	+	+	o	+	Rh pos. (Rh_1)
2. Mrs. B. M.	O	MN	o	o	o	+	Rh neg.
3. Mrs. B. H.	A	M	o	o	o	+	Rh neg.
4. Mrs. R. C.	A	MN	o	o	o	+	Rh neg.
5. Mrs. L.	O	MN	o	o	o	+	Rh neg.
6. Julian K.	B	M	+	+	o	+	Rh pos. (Rh_1)

The findings in the family of Julian K., whose blood lacks the factor, follow:

			Reactions with Anti-					
			D	C	E	c		Cellano
Father:								
John K., Sr.	O	MN	+	+	+	+	Rh pos. (Rh_1Rh_2)	+
Mother:								
Mary K.	AB	M	o	o	o	+	Rh neg.	+
Children:								
1. John	A	MN	+	o	+	+	Rh pos. (Rh_2)	+
2. Julian	B	M	+	+	o	+	Rh pos. (Rh_1)	o
3. Mrs. I. S.	A	M	+	+	o	+	Rh pos. (Rh_1)	+
4. Mrs. A. G.	A	M	+	+	o	+	Rh pos. (Rh_1)	+
5. Mrs. A. V.	A	M	+	+	o	+	Rh pos. (Rh_1)	o
6. Frank	B	M	+	+	o	+	Rh pos. (Rh_1)	o
7. Andrew	A	MN	+	+	o	+	Rh pos. (Rh_1)	+
8. Josephine	A	MN	+	+	o	+	Rh pos. (Rh_1)	+

Apparently, both parents are heterozygous for the factor so that 25% of the offspring are expected to be Cellano negative. Of the eight children tested, three were found to lack this new property.[3]

Assuming the presence of two genes at a particular locus on one of the chromosomes, their incidence could be calculated as follows:

Let Y = gene determining the presence of the Cellano factor and y = gene determining the absence of the Cellano factor

Then (1) $Y + y = 1$

(2) $y = \sqrt{\text{Cellano negative}} = \sqrt{.002} = .045 = 4.5\%$

(3) $Y = 1 - .045 = 0.955 = 95.5\%$

(4) $Y^2 + 2Yy + y^2 = 1$

(5) $(.955)^2 + 2(.955)\ (.045) + (.045)^2 = 1$

(6) Cellano homozygous = .912 or 91.2%
Cellano heterozygous = .086 or 8.6%
Cellano negative = .002 or 0.2%

Blood lacking the factor can be expected only in the offspring of the following matings:

$Yy \times Yy = 8.6 \times 8.6 = 0.74\%$ of all matings (1:135)
$2Yy \times yy = 2(8.6)(0.2) = 0.03\%$ of all matings (1:3333)
$yy \times yy = (0.2)(0.2) = 0.0004\%$ of all matings (1:250,000)

In the remaining matings (99.23%), all the offspring must be Cellano positive.

In a series of 150 Negroes, all blood specimens were found to contain the Cellano factor.

In the white population of the United States, the Cellano factor has a greater incidence than any other factor, exceeding the factor e (h″) by 2.8% (*7*). In this connection, it may be noted that in American Indians (*3*), and Chinese (*6*), the D factor (Rh_0) has an incidence of 99% or higher, and certain races of American Indians are almost exclusively of group O.

Correlated studies indicate that the Cellano factor is independent of the AB, MN, and Rh-Hr systems. This view was confirmed in a study of the Cellano serum made available to Dr. R. R. Race and his colleagues (*8*).

A list of Cellano negative blood is being prepared for the purpose of identification of other antibodies which are characterized by a high incidence of positive reactions. Such blood would be essential for transfusing those rare patients who may have produced this antibody and also for transfusing their affected infants.

The genetic homologue of the Cellano factor, when found, would be a blood property present in 8.8% of the same population of which 0.2% would be homozygous and 8.6% heterozygous. Two human antibodies have been described which do give a frequency of positive reactions closely approximating this value (anti-Lutheran 8% and anti-Kell 7%) (*2*, *1*).

Parallel tests on the above-mentioned family with the anti-Cellano serum and two specimens of anti-Kell serum, one of which was supplied by Dr. R. R. Race, show that the genes for Cellano and Kell antigens are alleles (*5*). The findings indicate that both parents are heterozygous for Kell as well as for Cellano. This would lead to an expectation among their offspring of $\frac{3}{4}$ Kell positive and $\frac{1}{4}$ Kell negative. In exact agreement with this, and in striking contrast to the frequency of 8.8% calculated to exist in the entire population, six of the eight children were Kell positive.

For the sake of uniformity, the letters "*K*" and "*k*," already used by the British workers for the genes determining Kell positive and Kell negative reactions respectively, will be retained (*9*). The observations with anti-Cellano indicate that the gene *k* can now be considered as indicating the presence of the Cellano factor. As in the case of *M* and *N* and the three Rh-Hr systems, there are three genotypes (*KK*, *Kk*, *kk*) corresponding to three phenotypes.

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[3] For these specimens the authors are indebted to Mr. Benson Rosenberg, Elizabeth Biochemical Laboratory, Elizabeth, New Jersey, who also tested 850 random blood specimens, all of which contained the Cellano factor.

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A New Time Scale for Kymograph Recording

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In laboratory experiments involving the kymograph recording of biological responses a time line is generally traced on the smoked paper, together with the experimental record. This time line allows the observer to correlate the observed phenomenon with absolute time.

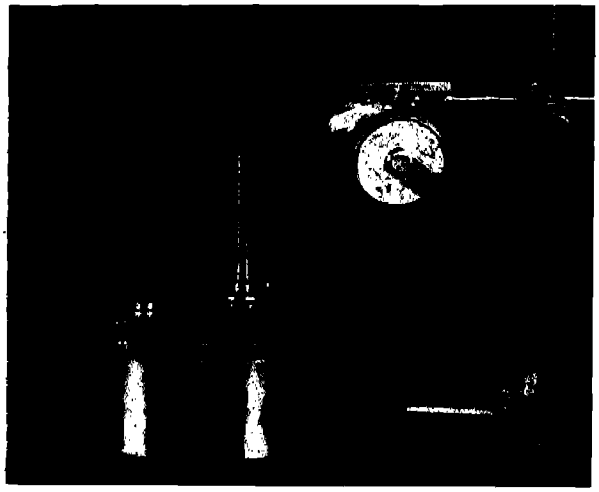

FIG. 1. The new interval timer for kymograph recording, in use.

With the usual equipment available in the laboratory, tracing this time line involves the use of signal magnets, dry cells, and a signal source. Failure on the part of any of these units leads to inconveniences. When the signal source is centrally located and is used by several investigators in different experiments, the adjustment of the signal may not be suitable for all. To overcome these troubles, a small instrument which is independent of such auxiliary apparatus has recently been developed. This instrument is a small self-contained unit (Fig. 1) which will trace a characteristic time scale when plugged into any 110-volt, 60-cycle circuit. Although the intervals on this scale are not adjustable, the form of the time scale traced makes it suitable for use over a wide range of kymograph speeds. (See Fig. 2.)

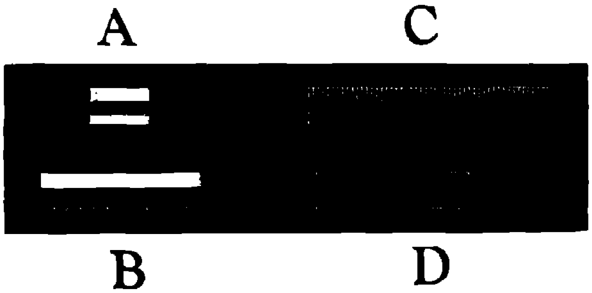

FIG. 2. Four examples of the new time scale for kymograph recording, illustrating its enormous range. The upper base line indicates intervals of 1 sec (long lines) and ⅕ sec (short lines). The lower base line similarly indicates 1-min and 10-sec intervals. Note that, at very slow drum speeds, the 1-sec and ⅕-sec divisions merge into a solid phalanx. (A) At drum speed of 0.5 mm/min. (B) At drum speed of 10 mm/min. (C) At drum speed of 200 mm/min. (D) At drum speed of 3000 mm/min.

The instrument used to trace the time scale operates as follows: Two very light styli (A and B in Fig. 3) spaced 4 mm apart trace the base lines. The upper stylus (A) is struck from above by an impactor (C) at a rate of five impacts per sec. Every fifth impact is heavier than the others. This results in the tracing of a longer line than the others. Thus 1-sec division lines are traced, each divided by four shorter lines representing 1/5-sec intervals. These lines extend downward from the upper base line. The lower stylus (B) is struck from below by another impactor (D) at a rate of one impact in 10 sec, each sixth impact being heavier than the others. Thus 1-min division lines are traced, each minute being divided into six divisions of 10 sec each. These lines extend upward from the lower base line. The adjustment is such that the 1-min and 10-sec divisions align exactly with the corresponding 1-sec division lines. The impactors are operated by cams (E and F) driven by a small self-starting synchronous motor. The accuracy of

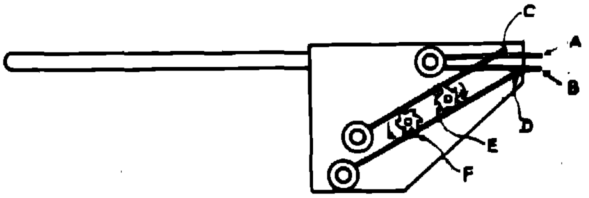

FIG. 3. The new interval timer for kymograph recording, as seen from the rear with cover removed.

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[1] I am grateful to Dr. Warren H. Yudkin (now at Cambridge University, England) for pointing out the inconveniences of older methods and for requesting a solution of the problem, and to Dr. Edgar J. Boell of Yale University for making available to me facilities for testing the timer and for his helpful advice.

the intervals is ensured by the 60-cycle alternating current.

Both impactors follow a path of motion which is oblique to the deflection of the styli levers. The object achieved by this disposition of the impactors is the dissipation of sufficient energy by frictional contact to prevent rebound, which would cause the tracing of fuzzy division lines between intervals. The impactors are light in weight and do not strike the styli until they have reached their maximum velocity. Their high velocity is then transmitted to the styli, ensuring sharp graduations.

Records made with this instrument are shown in Fig. 2. It is apparent that, at either moderately slow or moderately fast speeds of the kymograph drum, the time scale traced on the paper can be read clearly. Due to the nature of this time scale no adjustment of the intervals traced by this instrument is necessary when changing drum speeds within very wide limits.

A new nonadjustable interval timer is described which traces a characteristic time scale on kymograph records (Fig. 2). The distinctive nature of the time scale traced allows its use on most records of moderate speed. It records intervals from 1/5 sec to 1 min. The timer described is a self-contained unit which requires no dry cells or signal magnet but merely an electricity supply of 110-volt, 60-cycle alternating current.

Induction of Cytogenetic Changes and Atypical Growth by Hexachlorocyclohexane

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We have treated with insecticides containing hexachlorocyclohexane the seedlings of the following plants: *Zea mays, Triticum vulgare, T. monococcum, T. compactum, Secale cereale, Setaria italica, Panicum miliaceum, Helianthus annuus, Crepis capillaris, Vicia faba, V. sativa, Brassica nigra*, etc. The insecticides chiefly used were: Agrocide 7, Agrocide 8, hexachlorane, 666. The main active substance of the first two is the gamma isomer of 1,2,3,4,5,6-hexachlorocyclohexane. The others contain gamma isomer and some of the other isomers. Crystals of almost pure gamma isomer display the same activity as these.

The cytological studies of the affected root, stem, and coleoptile tissues show that the agents act first upon the cytoplasm and interfere with the cytoplasmic processes involved in the formation of achromatic figures. The chromosomes do not arrange in an equatorial (metaphase) plate after prophase, but remain scattered approximately as they are during the prophase. They appear less bent than usual. The thickening of the chromosomes and their reproduction and splitting proceed, regardless of the fact that the processes involved in the formation of achromatic figures are highly disturbed or even entirely inhibited. Poles are not formed. After reproduction, the chromatolytic (nucleoproteolytic) processes proceed, and a nucleus is formed containing twice as many chromosomes as at the start of the abnormal mitotic processes. The main trend of the processes of chromosome doubling recalls those induced by colchicine, acenaphthene, and other polyploidizing agents.

Since the insecticide continues to act further, the next abnormal (Ab-) mitosis ends with a second chromosome doubling, and so on. Thus tetraploid and octoploid cells and cells of a much higher polyploid degree are formed. Along with these, certain diploid cells that have not yet undergone Ab-mitosis can still be found.

Chromosome multiplication leads to increase in the size and occasionally in the number of the nuclei and further to increase in the size of the cells. Thus the cells grow instead of multiplying and differentiating, bringing about the swelling of the roots, stems, and coleoptiles.

The chromosome reproduction and separation in *Zea mays* should be considered as a somewhat special case. We have observed in a series of cells that the chromatids of the somatic chromosomes bend at the centromeres reciprocally toward each other, each being shaped like a V, and together forming a X, the chromatids being attached at the centromere. These figures can be interpreted by postulating certain repulsion forces existing between the chromatids, the reproduction (or division) of the centromere being somewhat delayed. This phenomenon occurs when the chromatic figure is highly or completely disturbed. In other words, it does not seem to be regulated to a very great extent by the forces exerted by the achromatic figure.

The solubility of hexachlorocyclohexane in water is very low; therefore, it is applied in the form of small solid particles. The particles act when they are in contact with the plant tissue. It has a specific odor, but the experiments failed when we tried to induce specific atypical growth from a distance. In this respect its effect differed from that of acenaphthene. For the sublimating particles of the acenaphthene act even when the crystals are not in contact with the plant tissue.

The effect of hexachlorocyclohexane is so striking that it can be used as a polyploidizing agent, especially when one considers that it is much cheaper than other such agents.

In certain cases one or more chromosome groups may move slightly in various directions into the cytoplasm. Such a slight separation may occasionally end in the formation of two or more aneuploid nuclei; thus polynucleate cells or cells with monstrously deformed nuclei arise. In certain cases a cell wall is formed between such nuclei. This leads to the formation of cells with aneuploid chromosome numbers. Dead cells were occasionally found in the roots, stems, and coleoptiles; they may have been aneuploid.

All these phenomena are due to the activity of the agent upon the cytoplasm.

The active agent may also induce certain changes in the nuclear elements, i.e., in the chromosomes. Chroma-tid and chromosome fragments were also observed, although rarely.

Such insecticides or fungicides, when applied, may increase hereditary changes in cultivated varieties ("pure lines"), leading thus to more rapid degeneration of the highly bred, uniform varieties. This means that when such insecticides or fungicides are applied the seeds of the propagated varieties should be changed more often so as to secure new nondegenerated stocks.

Rumen Bacteria in Cobalt-Deficient Sheep

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C. N. Stark, and J. K. Loosli

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In 1944, McCance and Widdowson (*4*) suggested that cobalt may function in connection with the rumen bacteria. This view was based on a communication from C. J. Martin who stated that sheep suffering from "Coast Disease" were cured by feeding cobalt but not by cobalt injection. Cobalt deficiency does not occur in horses, according to Marston (*3*). Attempts to produce cobalt deficiency in rats (*3, 8*) and in rabbits (*7*) have been unsuccessful. Thompson and Ellis believe that cobalt is needed only by ruminants and that it may be concerned with biological processes in the rumen. Recently, Ray *et al.* (*5*) observed a definite response in hemoglobin and gain in weight in cobalt-deficient sheep injected with cobalt, but the response was much less than in animals fed cobalt.

In an attempt to obtain direct evidence which might show with some certainty whether or not cobalt deficiency influenced the bacteria of the rumen, studies were undertaken to measure the bacterial activity of rumen samples. Twenty-one Western yearling sheep became cobalt-deficient after being fed a ration low in cobalt for 8 months. At this time the sheep were losing weight, and had poor appetites and low hemoglobin values (*6*). These sheep were then divided into three equal groups. The first group was fed 1 mg of cobalt per day, while the second received the same amount of cobalt by injection. The remaining seven sheep were kept on the deficient ration. After 1 week sheep fed cobalt were gaining weight, and had good appetites and increased hemoglobin values, while those on the basal ration alone or those injected with cobalt continued to decline. At this time the rumen contents of four sheep from each group were sampled by stomach tube for bacteriological study, and the remaining sheep were sampled the following week. Six additional sheep were maintained for 1 month on a restricted feed intake comparable to that of the cobalt-deficient sheep. These sheep were then sampled to determine the effect of lowered feed intake *per se* on rumen bacteria. The sheep received adequate cobalt in the ration and ate 60% or more of the ration eaten by the sheep fed cobalt. The kinds and number of bacteria present in the rumen contents of the four groups of sheep were compared by means of Gram stains, direct slide counts, and anaerobic cultures (*1*).

The results of the slide counts and cultural tests are summarized in Table 1.

TABLE 1

INFLUENCE OF DIET ON RUMEN BACTERIA

Dietary group	No. of animals	Bacterial slide count	Cultural results—No. growing in dilutions 10^{-7}	10^{-8}	10^{-9}	10^{-10}	10^{-11}
		billions/gm					
Cobalt-deficient	7	30.2	7	7	2	0	0
Cobalt injected	7	30.7	7	5	3	0	0
Cobalt fed	7	54.6	7	7	7	5	2
Restricted feed intake	6	56.3	6	6	5	3	1

Culturally, there were major differences between the dietary groups. The samples from sheep fed cobalt gave the highest cultural counts, all cases showing growth in the 10^{-9} dilution, 5 in 10^{-10}, and 2 in 10^{-11} dilution of rumen contents. In marked contrast, only 2 cobalt-deficient and 3 cobalt-injected animals showed bacterial growth in the 10^{-9} dilution, and neither group gave growth above this dilution. Bacteriologically, sheep on restricted feed intake but fed sufficient cobalt resembled those fed cobalt and unlimited feed. Both the kinds and numbers of bacteria in the rumen content of sheep fed cobalt resembled those of sheep fed normal rations (*1*).

It can be seen by slide count that cobalt-fed sheep had almost twice as many bacteria per g of rumen contents as cobalt-deficient and cobalt-injected animals. The bacterial slide count of sheep on restricted feed intake was about the same as that of sheep fed cobalt.

Gram stains of samples were identified only by number, which had no significance to the examiner, but after microscopic study it was possible, on the basis of the stains alone, to separate cobalt-deficient sheep from cobalt-fed animals. In 5 out of 7 cases, Gram stains from cobalt-injected sheep were grouped with cobalt-deficient sheep; while in the other two instances, the bacterial picture was not clearly typical of either group.

Gram stains from sheep fed cobalt were characterized by the usual wide variety of bacteria with large numbers of *Gram-positive, slender curved rods,* and *coccoid types* of bacteria covering the fibers, which were in an advanced stage of decomposition. The slides from cobalt-deficient and cobalt-injected sheep were recognized because of a complete lack of slender curved rods, and a great reduction in the numbers of coccoid forms on the fibers. The fibers were only slightly disintegrated. The differences in the bacterial picture between the groups lay more in the absence of these bacteria in cobalt-deficient and cobalt-injected animals than in a complete change of flora. Gram stains from sheep on restricted feed intake were similar to those of animals fed cobalt.

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These data show that in cobalt deficiency marked alterations occur in the types and numbers of bacteria in ruminants and that these bacteriological changes are not caused by lowered feed intake of the deficient animals.

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Spectrophotometric Determination of Amino Acids by the Ninhydrin Reaction

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In view of the growing interest in the separation of amino acids by partition paper chromatography (*1, 2, 3, 4, 7, 8*), studies have been made to determine if a quantitative relationship might be established in the colorimetric reaction between ninhydrin and the amino acids. Harding and MacLean (*5*) first developed this reaction and later (*6*) condemned it as a colorimetric method for amino acid determination. In mixtures of amino acids they found a lack of specificity and a variation in the red and blue colors produced in the reaction, since ammonia and amines other than amino acids formed similar colors with ninhydrin.

Solutions of 13 amino acids were prepared by dissolving 2 mg of each in 80% ethanol. The ninhydrin reagent was prepared by dissolving 200 mg of ninhydrin in 100 ml of isobutanol. Fifty γ of each amino acid were placed into a test tube, 2 ml of ninhydrin reagent added, and the total volume made up to 10 ml with isobutanol. It was observed in many trials that the color would develop by itself at room temperature. However, to make conditions uniform, all tubes were incubated at 80° C for 3 min, removed, and cooled under running water to 22° C for 3 min. Each tube was then immediately placed in a Coleman No. 6 spectrophotometer, and the transmission determined at 10 mμ intervals between 400 and 700 mμ against a standard containing 2 ml of ninhydrin reagent and 8 ml of isobutanol until the inflection point was approached when the measurements were made at 5 mμ intervals.

The wavelengths corresponding to the inflection points in the wavelength-% transmission curves of amino acids are presented in Table 1.

TABLE 1

WAVELENGTH OF MAXIMUM ABSORPTION OF AMINO ACIDS REACTED WITH NINHYDRIN

Amino acid	Wavelength in mμ	Amino acid	Wavelength in mμ
Phenylalanine	580	Glycine	555
Lysine	545	Methionine	560
Threonine	550	Valine	560
Tryptophane	550	Arginine	560
Alanine	550	Norvaline	560
Asparagine	550	Isoleucine	565
Leucine	555		

Serial dilutions of the amino acids were made and, after reaction with ninhydrin, measured spectrophotometrically at the appropriate wavelength. The quantitative limits in γ, within which it appears possible to measure spectrophotometrically amino acids which have reacted with ninhydrin under the described conditions, that is, the limits at which the points of a plot of concentration vs. logarithm of transmission fall on a straight line, are presented in Table 2.

TABLE 2

LIMITS OF THE SPECTROPHOTOMETRIC DETERMINATION OF AMINO ACIDS REACTED WITH NINHYDRIN*

Amino acid	Concentration (γ per 100 ml)	Amino acid	Concentration (γ per 100 ml)
Phenylalanine	10–140	Threonine	20–130
Isoleucine	20–125	Tryptophane	20–200
Leucine	10–100	Glycine	10– 80
Lysine	5– 50	Alanine	10– 80
Methionine	10–100	Asparagine	20–180
Valine	10–100	Norvaline	10– 70
Arginine	20–100		

* Within these limits the transmission was a straight line.

From the results of these determinations it appears feasible to adapt these studies to the quantitative estimation of amino acids separated by the partition paper chromatographic method. Transmission curves could be determined, and the quantities of specific amino acid present thereby measured in appropriate dilution.

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Book Reviews

The conquest and colonization of Yucatan, 1517–1550. (Publ. 582.) Robert S. Chamberlain. Washington, D. C.: Carnegie Institution, 1948. Pp. vii + 365. (Illustrated.) $4.75, paper; $5.50, cloth.

In any historical or scientific writing, the background of the author plays an important part. Probably few historians in the American field have a more imposing background in the history of Spanish conquests than Robert Chamberlain. The number of bibliographical works concerning Spanish conquests in Yucatan, especially by those conquistadores, the Montejos, have largely resulted from Robert Chamberlain's researches. This book may be regarded as the consolidation of a whole series of accomplishments in this direction.

The author has pointed out the great importance of an exhaustive work concerning the conquest of Yucatan. This phase of the New World enterprises of the Spanish is certainly the least known of any. The conquest of the Valley of Mexico and of the surrounding peoples has been exhaustively chronicled from several viewpoints. Spanish entradas in northern Mexico and the Southwest have also aroused considerable historical enthusiasm. Pizarro's conquests of the vast Inca state are known to every casual student. The more important explorations and conquests of Yucatan by the Spanish have been heretofore inexplicably slighted. Yucatan was the first portion of the mainland of the Americas west of Cuba to be discovered, but it was the last area of these coasts to be subjugated. This sequence seems to have been followed by present day scholars. Even the name of the great conquistador, the Adelantado, Francisco de Montejo, is little known. Robert Chamberlain ably brings out the qualities of Montejo during the many difficulties of the Spaniards' in exploring and pacifying Yucatan. The publication of *The conquest and colonization of Yucatan* assures the name of Montejo its just place with Cortés, Pizarro, Balboa, Jiménez de Quesada, Alvarado, and Valdivia.

The Spanish history in relation to Yucatan is closely followed from the time of the discovery and the initial phases of the conquests, through the many entradas and colonization attempts, to the final conquest after the great Maya revolt. The last portion of the book deals with the first years of the colony to the middle of the 16th century. Francisco de Montejo, into whose hands the Castilian Crown gave the occupation of Yucatan, had interests in addition to Yucatan proper; consequently the history includes other areas adjacent to Yucatan. Montejo had his eyes fixed on other areas—Honduras and Higueras, the region of Golfo Dulce and Chiapas. The history of these neighboring provinces was inextricably interwoven with that of the Mayan area.

It would be a strange book indeed that a reviewer could not criticize in some minutia. The controversial points are of little importance, however. In cases of possible doubt the author has carefully cited the original texts in elaborate footnotes. By the very nature of these early sources, there were controversial accounts and mutually exclusive data and dates. The author has reviewed and weighed the evidence carefully in all cases. In many instances Mr. Chamberlain has exhibited a thorough knowledge of the background of his subject over and above purely historical facts. He displays an intimate acquaintance with the encomienda system, for example, without which knowledge much of the Spanish history in Yucatan is inexplicable. The bibliography and footnote structure of this book convinces this reviewer that the author has made adequate use of all known sources relating to the history and conquest of Yucatan.

The conquest and colonization of Yucatan is a significant work on the background of the European advent in the Americas. Between two covers, Robert Chamberlain has collected all of the data pertinent to this period, indicated the significant features, and authenticated the whole.

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Fatigue and impairment in man. S. Howard Bartley and Eloise Chute. New York: McGraw-Hill, 1947. Pp. 429. $5.50.

This book proposes a thesis that conflict and frustration are cardinal factors in the etiology of fatigue and at the same time provides, unwittingly, excellent material for testing this hypothesis. For the reviewer, the theory has "worked." He became frustrated. And he became tired. On checking with others who read the volume he was able to verify that his was not an exceptional, idiosyncratic reaction.

Throughout, the treatment suffers from a basic dilemma. Arbitrarily, the authors limit the meaning of fatigue to the experience of feeling tired. They use the term impairment for the objective, biochemical and physiological alterations present in a variety of situations in which the human organism is placed under strain. Their primary interest is in fatigue, not in impairment. Yet most of the book is devoted to impairment. The result is a definite lack of balance.

There is need for a detailed summary of the results and problems of "stress" physiology, taking into account the phenomena of both adaptation and breakdown of the adaptive mechanisms. This need became even more acute as a result of the accumulation during the war years of a large mass of new data on the effects of extremes of environmental temperature, high altitude, nutritional deficiencies, strenuous work, participation in combat, etc. This undertaking is beyond one man's competence and capacity. At any rate, the summary attempted by Bartley and Chute does not fill the need for a comprehensive and up-to-date treatment.

The part devoted to fatigue as a subjective experience is also unsatisfactory, but for other reasons. The amount of valid and usable information available in the literature is small and there is, consequently, little to summarize. Bartley's own work in this area is very limited. The role of "conflict" in the causation of fatigue was developed in the course of his studies on the pupillary reflex (1942). Later (1943) conflict (and frustration), defined as "any clash, incompatibility or disharmony occurring at any level of organismic activity," was assigned a universal role in fatigue. Most of the discussion is based on arm-chair analysis.

The emphasis on the attitudes and motivation of persons in whom fatigue is being studied is wholesome. Few will disagree with the author's statement that the subjective phenomena of fatigue cannot be treated in a simple quantitative fashion. However, no constructive suggestions, useful to the experimenter or the clinician, such as using more sophisticated, standardized inventories, were submitted. Improved methods are a *sine qua non* condition of rising above the stage in which "most of what we know about fatigue arises from everyday observations and from deductions made from these" (p. 400).

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Scientific and industrial glass blowing and laboratory techniques. W. E. Barr and Victor J. Anhorn. Pittsburgh, Pa.: Instruments Publ., 1949. Pp. viii + 380. (Illustrated.) $6.00.

Three objectives are outlined and admirably attained in the 15 chapters of this book. The first objective is to give instruction in glass blowing, with many elementary details and drawings, covering a simple junction of two pieces of glass and ending with the making of a complicated ground glass stopcock. Shop layout, burner designs, the chemical and physical properties of glasses of American and imported types and other related topics help to broaden the reader's knowledge. A chapter on glass-to-metal seals covers the principles involved, the combinations of metals and glasses available, their properties, and the production of lamps and tubes with such seals.

The second objective is to present advanced techniques required for the production of high vacua. Two chapters describe many types of vacuum pumps and vacuum gages in great detail, including their calibration and uses. There is a chapter on high vacuum techniques which includes silvering methods, gas evolution from hot glass, and a host of other items.

The third objective is to describe in great detail four types of special glass equipment with the aid of other authorities, such as Joyner on gas adsorption apparatus, Hanson on molecular weight apparatus, Anderson on Swietoslawski ebulliometers. A long chapter is devoted to distillation problems, including theoretical discussion and operating requirements of fractionating and distillation columns and condensers. Vacuum fractionating equipment and molecular stills also are described.

Each chapter is concluded with adequate literature references, and the index refers to subject matter only. The book will appeal to people of varying interests, but the emphasis is mainly on chemical scientific apparatus and the title might well have indicated this. There will be differences of opinion on the details of construction, but not on the main points covered. With so much material there are bound to be errors, such as the Dushman reference on page 191, and the chemical composition of DG glass on page 124.

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The essentials of organic chemistry. C. W. Porter and T. D. Stewart. Boston, Mass. and London, Engl.: Ginn, 1948. Pp. vi + 394. (Illustrated.) $4.00.

Professors Porter and Stewart have provided a textbook for a short course in organic chemistry. They have covered most of the basic and established facts and theories of this branch of learning in a simple style that should be easily comprehensible to a beginning student. The book is designed primarily for nonscience majors. It is equipped with exercises and problems at the end of each chapter and with adequate diagrams, tables, and equations to illustrate the textual discussions.

It should have been possible for the authors to incorporate some of the more important and interesting new products, processes and theories without lengthening the book unduly. Such developments as the silicones, the oxo process, and the carbonium ion theory of rearrangements are either not mentioned or are inadequately treated. Statements such as the following are inaccurate or grossly misleading: "Animal parasites are called trypanosomes; examples are the hookworm, the amoeba which causes dysentery, . . ." (p. 361); "A reaction which is not given by aliphatic ketones, but which occurs readily with aromatic ketones, is the Clemmensen reduction" (p. 331); "The hydroxyl group of a phenol, however, may be replaced with chlorine by heating the phenol with phosphorus pentachloride" (p. 300). The last statement is not qualified in any way and creates the false impression that satisfactory yields are ordinarily obtained with all phenols.

Aside from this sort of inaccurate statement, however, the book is remarkably free from errors. It is well printed and bound and presents an attractive appearance. The authors have produced a work which should be popular in many colleges.

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Association Affairs

Local Committees for the 1949 Annual Meeting of the AAAS in New York City. The establishment of local committees to direct the preparations for the 116th Meeting of the American Association for the Advancement of Science, December 26–31, in New York City, began auspiciously when **J. W. Barker**, president of Research Corporation and formerly dean of the Faculty of Engineering, Columbia University, accepted appointment as general chairman, with the responsibility of coordinating the activities of all local committees. Dr. Barker, whose training was received in the University of Chicago and Massachusetts Institute of Technology, is eminently qualified for this post. In World War I he rose from second lieutenant to major in the Coast Artillery Corps and served on the faculties of M.I.T. and Lehigh before assuming the deanship at Columbia. Dr. Barker has been vice president of the American Institute of Electrical Engineers and vice president and president of the Illuminating Engineering Society; he was special assistant to the Assistant Secretary of the Navy, and in 1937 he was chairman of AAAS Section M.

A local Advisory Committee, headed by **George B. Pegram**, vice president of Columbia University (the general chairman of the 1928 New York City Meeting) and including **William J. Robbins**, director of the New York Botanical Garden; **Albert E. Parr**, director of the American Museum of Natural History; and **Sam F. Trelease**, Torrey Professor of Botany, Columbia (on the General Local Committee in 1928), has been serving since early March. The complete personnel of the local committees on Reception and Entertainment, Equipment and Projection, Publicity, Finance, Reference, and General Sessions and Lectures will be announced in *Science* when they are organized. The success of the Annual Meeting of the Association depends in very large measure on the efforts of the local committee members who give so generously of their time; this will be particularly true of the New York City Meeting.

In order to increase participation in the **Gordon Research Conferences** (to be held this year at Colby Junior College, New London, New Hampshire, from June 20 to September 2, as announced in *Science*, March 4), two significant procedures have been established by recent action of the Management Committee and the Advisory Board. First, the registration fee has been increased to provide each conference with a small fund to pay part of the expenses of participants who would otherwise be unable to attend, the money to be allocated by the chairman in consultation with the director. And second, the advisory board has been enlarged to include fifteen nonsponsor representatives from colleges and universities. Five individuals are to be elected each year for a term of three years. The first five elected this year are Paul Bartlett, Harvard University; John Bowman, Mellon Institute of Industrial Research; C. A. Elvehjem, University of Wisconsin; Paul Flory, Cornell University; and H. S. Taylor, Princeton University.

The Management Committee, in cooperation with the Advisory Board, is responsible for operating the annual conferences. The Advisory Board consists of an official representative from each of the 57 industrial companies that sponsor the conferences through the American Association for the Advancement of Science. Members are named by the sponsors and serve indefinitely. The conference chairmen each year also serve on the Board. The Management Committee is elected from the Advisory Board, two members being chosen each year to serve for a term of three years. The present committee is Emil Ott, chairman, Hercules Powder Company; K. G. Compton, vice chairman, Bell Telephone Laboratories; Dean Burk, National Institutes of Health; George Calingaert, Ethyl Corporation; S. S. Kurtz, Jr., Sun Oil Company; Randolph T. Major, Merck & Company; Howard A. Meyerhoff, AAAS; and W. George Parks, director, Rhode Island State College.

The Management Committee selects the conference director, decides where the conferences are to be held, and concerns itself with finances and other details of operation, as well as formulating future plans and policies, for consideration by the Advisory Board. A survey of the present conferences is in progress now under the direction of S. S. Kurtz, Jr., to be used as a basis for future plans and developments.

W. George Parks.

The Laurentian Hormone Conference of the AAAS will hold its 1949 meeting at the Forest Hills Hotel, Franconia, New Hampshire, September 12 to 17. The following program has been arranged:

I. Ovarian Physiology and Function

Monday evening, September 12. Biology of the Ovary: A. S. Parkes, National Institute for Medical Research, London.

Tuesday morning, September 13. Physiology of Estrogenic Hormones: K. E. Paschkis and A. Rakoff, Jefferson Medical College.

Tuesday morning, September 13. Maintenance of the Corpus Luteum and Physiologic Actions of Progesterone: James T. Bradbury, Willis E. Brown, and Laman A. Gray, State University of Iowa and University of Louisville.

Tuesday evening, September 13. The Vasculature of the Ovary and Ovarian Function: S. R. M. Reynolds, Carnegie Institute of Washington.

II. Chemistry and Physiology of the Sex Hormones

Wednesday morning, September 14. Studies with Estrogen Conjugates: G. A. Grant and D. Beale, Ayerst, McKenna & Harrison, Ltd.

Wednesday morning, September 14. Chemical Methods for the Estimation of Steroid Hormones and their Metabolites: Lewis Engel, Massachusetts General Hospital.

III. PITUITARY PHYSIOLOGY AND FUNCTION

Thursday morning, September 15. Pituitary Control of Steroid Secretions: Roy O. Greep, Harvard School of Dental Medicine.

Thursday morning, September 15. The Present Status of Posterior Lobe Hormones: Robert L. Noble, University of Western Ontario.

IV. HUMORAL MEDIATORS IN NERVOUS TRANSMISSION

Thursday evening, September 15. Sympathetic Neurohumors: M. L. Tainter and F. P. Luduena, Sterling Winthrop Research Institute.

Friday morning, September 16. The Acetylcholine System in Neural Function: Ralph W. Gerard, University of Chicago.

V. HORMONES AND TUMORS

Friday morning, September 16. Experimental Endocrine Tumors: George W. Woolley, Roscoe B. Jackson Memorial Laboratory.

Friday evening, September 16. The Virilizing Syndrome in Man: Lopis J. Soffer, J. Lester Gabrilove, Joseph W. Jailer, and Mildred D. Jacobs, Mount Sinai Hospital.

VI. MECHANISMS OF HORMONE ACTION

Saturday morning, September 17. Effects of Hyperglycemic Factors of the Pancreas and of Epinephrine on Glycogenolysis: Earl Sutherland, Washington University, St. Louis.

Saturday morning, September 17. Hormone-Enzyme Relationships: Roland K. Meyer, University of Wisconsin.

Attendance is limited by the available hotel accommodations, but the Committee on Arrangements invites applications for attendance from interested investigators and specialists in the hormone field. The Committee consists of R. W. Bates, E. R. Squibb & Company; E. C. Reifenstein, Jr., Sloan-Kettering Institute; A. White, School of Medicine, University of California at Los Angeles; and G. Pincus, Chairman, The Worcester Foundation for Experimental Biology. Applications for attendance should be sent to the Chairman at 222 Maple Avenue, Shrewsbury, Massachusetts, and must be received by *June 6*.

The Springfield chapter of the AAAS met March 31 at American International College. Dr. S. A. Simon, Chicopee Manufacturing Company chemist, spoke on the subject of fibers, discussing their synthesis, structure, function, and purposes, in nature and in the laboratory, and the techniques used to study them.

NEWS and Notes

Charles E. Sando, U. S. Department of Agriculture plant chemist, has been named project advisor for USDA Research on Crop Utilization, Bureau of Agricultural and Industrial Chemistry. Dr. Sando succeeds Cornelius E. Senseman, recently retired.

Robert A. Kehoe, of the University of Cincinnati, has received the Knudsen Award of the American Chemical Association of Industrial Physicians and Surgeons for his work in the field of industrial medicine. The award was made at the Association's annual convention held in Detroit, April 7.

Robert Lindley Murray, executive vice president of the Hooker Electrochemical Company, Niagara Falls, New York, has been awarded the 1949 Jacob F. Schoellkopf Medal of the Western New York Section of the American Chemical Society. Dr. Murray was cited for his engineering ability and his able direction of chemical research and development in the chlorine and alkali industry.

Gregor Wentzel, University of Chicago physicist, will be a visiting professor at Stanford University during the summer quarter. While there he will offer a course on recent developments in quantum electrodynamics.

The National Academy of Sciences made the following awards at its annual dinner held April 26 in Washington, D. C.: The Cyrus B. Comstock Prize of $3,500 to **Merle A. Tuve**, director, Department of Terrestrial Magnetism, Carnegie Institution of Washington, D. C., for his work in nuclear physics, geophysics, and development of the proximity fuse; the James Craig Watson gold medal and honorarium to **Samuel Alfred Mitchell**, director of the Leander McCormick Observatory, University of Virginia, for his many services to astronomy; the Mary Clark Thompson gold medal and honorarium, in absentia, to **Frank McLearn**, of the Canadian Geological Survey, in recognition of his contribution to geologic science; and the Public Welfare Medal to **George Harrison Shull**, professor emeritus of botany and genetics, Princeton University, in recognition of his improvement of the maize crop.

Ernst Mayr, curator of the Whitney-Rothschild Collections of the American Museum of Natural History, is serving as guest lecturer in the Department of Zoology at the University of Minnesota for the spring quarter and is offering a graduate course on the "Origin of Species and Other Problems of Evolution."

Arvid Lundquist, president of the American Society of Swedish Engineers in New York, has been awarded the Swedish Royal Order of Vasa, with the rank of knight.

William T. Salter, chairman, Department of Pharmacology, Yale University School of Medicine, was awarded the first $1,000 Iodine Educational Bureau award (see *Science*, September 17, p. 298) at the recent annual meeting of the American Pharmaceutical Association.

Robert W. Kleemeier, professor of psychology at Northwestern University, has been appointed director of the newly established laboratory for gerontology and geriatrics at Moosehaven, Florida, effective September 15.

Frans Verdoorn, botanist, has resigned as director of the Los Angeles State and County Arboretum at Arcadia, California, and will resume his editorial work at Waltham, Massachusetts. He will continue to serve the arboretum as a councilor.

Fellowships

The U. S. Atomic Energy Commission has instituted fellowships to be granted to qualified investigators who wish to work with radioactive isotopes at the Marine Biological Laboratory this summer. Each fellow will receive $250, and round trip traveling expenses from his university. Laboratory fees will be paid by the Commission. The work with isotopes will be under the general supervision of G. Failla, of the Department of Radiology, Columbia University. Applications should be addressed to Dr. Charles Packard, Marine Biological Laboratory, Woods Hole, Massachusetts.

The Allied Chemical and Dye Corporation announces renewal of its 31 graduate fellowship offerings for 1949–50, mainly in the fields of chemistry and chemical engineering. Each fellowship provides $1,200 and tuition. Recipients of the awards and the research to be conducted are to be selected by the 24 schools to which the fellowships have been offered: University of California, California Institute of Technology, Carnegie Institute of Technology, University of Chicago, Columbia University, Cornell University, Duke University, Harvard University, University of Illinois, University of Iowa, McGill University, Massachusetts Institute of Technology, University of Michigan, University of Minnesota, Northwestern University, Ohio State University, Pennsylvania State College, University of Pennsylvania, Polytechnic Institute of Brooklyn, Princeton University, Purdue University, Syracuse University, University of Wisconsin, and Yale University.

Colleges and Universities

Tulane University School of Medicine has announced the appointment of six faculty members to the staff of its newly reorganized department of psychiatry and neurology. They are: Robert G. Heath, chairman and professor of psychiatry and neurology; Robert Hodes, professor of experimental neurology; Norman H. Rucker and Theodore Treuting, assistant professors of psychiatry; Frank Garcia, instructor in neurology and neurosurgery; and David Freedman, assistant in neurology.

The United States Geological Survey will soon establish a new coal geology laboratory at **Ohio State University**, to be ready by this summer. The new laboratory is intended to bring together field and laboratory phases of coal investigations, and to facilitate the study of fossil plants that compose coal.

The University of California has announced that funds have been appropriated for a low-temperature laboratory at Davis to cost $1,000,000.

Summer Programs

The Massachusetts Institute of Technology announces a summer program in Food Technology, June 13–July 1, under the direction of William L. Campbell, head of the Department of Food Technology; Cecil G. Dunn, associate professor of Industrial Microbiology; Ernest E. Lockhart, assistant professor of Food Chemistry; Robert S. Harris, professor of Biochemistry of Nutrition; and Bernard E. Proctor, director, Samuel Cate Prescott Laboratories of Food Technology. Inquiries regarding registration should be sent to Prof. B. E. Proctor, Room 20-C-130, M. I. T., Cambridge, Massachusetts.

Ohio State University's Stone Laboratory at Put-in-Bay, Ohio, will offer eight courses during the first six-week term which opens June 21. Scheduled courses include both undergraduate and advanced studies in fish ecology, higher aquatic plants, invertebrate zoology, aquatic entomology, limnology, algalogy, ornithology, and fish physiology. Special problems and research will be undertaken during the second six-week term beginning July 28. Interested students should communicate with the laboratory regarding enrollment.

The Northeastern Section of the Botanical Society of America will hold its third annual summer excursion in Michigan August 20–28, under the auspices of the Cranbrook Institute of Science and the Botany Department of the University of Michigan. Registration by members will be accepted by Elzada U. Clover, Department of Botany, University of Michigan, Ann Arbor, until July 15. Nonmember registrations will be accepted if space is available. Further information may be obtained from Prof. Clover.

Meetings and Elections

The American University announces a five-day **Institute on Scientific Research and Development**, to be held June 5–10 in Washington, D. C., with the cooperation of the National Research Council and the AAAS. Persons engaged in administration of scientific research and development activities are eligible to attend the Institute.

Five major areas will be explored during several sessions of lectures and group discussions devoted to specific problems in (1) research organization, (2) the administrative process, (3) research personnel, (4) aids to research, and (5) the research product. Program plans have been developed by a committee from the three participating institutions: M. H. Trytten and Raymund L. Zwemer, National Research Council; Howard A. Meyerhoff and S. B. Fracker, AAAS; Catheryn Seckler-Hudson, George P. Bush and Lowell

H. Hattery, The American University.

Inquiries about the Institute should be directed to Lowell H. Hattery, The American University, 1901 F Street, N.W., Washington 6, D. C.

The American Academy of Neurology will hold its first annual meeting in French Lick Springs, Indiana, June 1–3. A. B. Baker, professor of neurology, University of Minnesota, is president of the newly formed organization.

The American Society for the Study of Sterility will hold its fifth annual conference at the Hotel Strand, Atlantic City, New Jersey, June 6–7. The registration fee of $10 includes the detailed program containing abstracts of papers to be presented. Registration should be made in advance since seating capacity is limited. Address requests to Walter W. Williams, Secretary, 20 Magnolia Terrace, Springfield, Massachusetts.

The Mathematical Association of America will hold a joint meeting with the Mathematics Division of the American Society for Engineering Education June 20–21 at the Rensselaer Polytechnic Institute, Troy, New York. The association will also meet at the University of Colorado, Boulder, on August 29–30.

Centre National de la Recherche Scientifique has announced two forthcoming conferences: one on **morphogenesis**, to be held in Strasbourg, July 5–12, and one on **adsorption and heterogeneous kinetics**, to be held in Lyon, September 12–17. U. S. scientists invited to participate in the Strasbourg conference are: P. R. White, Institute for Cancer Research, Philadelphia; F. Skoog, University of Wisconsin, Madison; and P. Weiss, Department of Zoology, University of Chicago. Those who will take part in the Lyon conference are Hugh S. Taylor, of the Frick Chemical Laboratory, Princeton University, and Paul H. Emmett, Mellon Institute of Industrial Research, Pittsburgh.

The International Union for the Scientific Study of Population will hold its first official assembly since the war, in Geneva, Switzerland, August 27–September 3. At the request of Unesco, two special sessions of the assembly will be devoted to considering the cultural assimilation of immigrants. Further information regarding the assembly may be obtained from Frank Lorimer, Administrative Director, International Union for Scientific Study of Population, American University, Washington 16, D. C.

The Mellon Institute and the University of Pittsburgh's School of Medicine will hold their second annual symposium on orthopedic appliances at the institute September 19–24. The symposium will be open to invited orthopedic physicians, surgeons, and technologists. Inquiries concerning attendance and program should be addressed to the Orthopedic Appliance Fellowship, Mellon Institute, 4400 Fifth Avenue, Pittsburgh, Pennsylvania.

The Southeastern Section of the American Physical Society elected the following officers at its annual meeting held at Clemson Agricultural College, Clemson, South Carolina, April 15–16: J. H. Howey, Georgia Institute of Technology, Atlanta, chairman; W. G. Pollard, Oak Ridge Institute of Nuclear Studies, Oak Ridge, vice chairman; Dixon Callihan, Carbide and Carbon Chemicals Corporation, Oak Ridge, secretary; Hugh F. Henry, Carbide and Carbon Chemicals Corporation, treasurer; and Francis G. Slack, Vanderbilt University, member of the executive committee.

The Wisconsin Academy of Sciences, Arts, and Letters held its 79th annual meeting April 19–20 at the University of Wisconsin, as part of the university's centennial program. The following officers were elected for the 1949–50 academic year: Robert K. Richardson, professor of history and archivist, Beloit College, Beloit, president; Allen Abrams, Marathon Paper Company, Rothschild, vice president in science; Lucia R. Briggs, Milwaukee-Downer College, Milwaukee, vice president in arts; R. M. S. Heffner, professor of German, University of Wisconsin, vice president in letters; H. O. Teisberg, State Historical Society, Madison, librarian; Banner Bill Morgan, associate professor of veterinary science, University of Wisconsin, secretary-treasurer.

NRC News

The newly reorganized **Agricultural Board of the Division of Biology and Agriculture,** National Research Council, held its first meeting April 11 at the National Academy of Sciences. The Agricultural Board will be an independent scientific review body whose announced purposes are: to advance and interpret scientific knowledge pertaining to agriculture, to initiate and provide recommendations relative to agriculture, and to disseminate technical and deliberative conclusions among the proper agencies and population groups.

Roy C. Newton, director of research for Swift and Company, Chicago, is chairman of the new board. Leonard A. Maynard, director of the Cornell University School of Nutrition, is vice-chairman, and LeRoy Voris of the NRC Food and Nutrition Board is acting executive secretary. Other members are: R. V. Boucher, Pennsylvania State College; J. S. Davis, Food Research Institute of Stanford University; H. R. Guilbert, University of California; W. A. Hagan, New York State Veterinary College, Cornell University; W. E. Krauss, Agricultural Experiment Station, Wooster, Ohio; W. J. Loeffel, College of Agriculture, Nebraska; L. C. Norris, Cornell University; B. T. Simms, Bureau of Animal Industry, U. S. Department of Agriculture; and W. W. Spink, University of Minnesota Medical School. It is expected that several more members will be added to the board to insure balance in all agricultural fields.

The present committees of the Agricultural Board are on Animal Health; Public Health Aspects of Brucellosis; Animal Nutrition; Feed Composition; Production, Distribution, and Quality of Milk; and Veterinary Services. Most of the committees have been in existence and active for some time prior to the reorganization of the board. The Committee on Animal Nutrition and its subcommittees have published *Recommended Nutrient Allowances* for poultry, swine, dairy cattle, beef cattle, and sheep; these have been widely accepted as standard and published in textbooks.

The Feed Composition Committee has recently made a survey of the nutritive value of hybrid corn, including vitamin, mineral, and proximate protein analyses. About 350 samples from different sources were investigated over a two-year period.

The Committee in Public Health Aspects of Brucellosis works in collaboration with the Division of Medical Sciences of the NRC. This committee, which estimates that brucellosis costs the livestock industry nearly $100 million annually, has published three reports on the disease, and is preparing definitive statements on the eradication of brucellosis in domestic animals and on the diagnosis of human brucellosis.

The Indiana Science Talent Search, sponsored by the *Indianapolis Times*, the Indiana Academy of Science, and the Indiana Junior Academy of Science, honored 20 promising contenders for the Westinghouse Science Scholarships at the first Indiana Junior Scientists' Assembly, held in Indianapolis, March 26. The Indiana project is a part of the Eighth Annual Talent Search conducted by Science Clubs of America, a Science Service activity.

The 20 finalists, including the eight National Honorable Mentions, were interviewed during the morning by the talent search committee and in the afternoon exhibited the experimental equipment they had used in preparing their essays. Walter Leckrone, editor of the *Indianapolis Times*, presided at an Honors Luncheon, attended by more than 200 people. Karl Lark-Horovitz, head of the Department of Physics at Purdue University, addressed the group on "Science of the 20th Century." Mr. Leckrone presented awards to the 15 winners. All 20 students have been recommended to the entrance officials and scholarship committees of Indiana colleges and universities. Information on each of the 73 Indiana high school seniors who completed entrance requirements for the talent search was submitted to the college or university of his choice.

Members of the talent search committee are: R. W. Lefler, Department of Physics, Purdue University, Lafayette, chairman; Lawrence H. Baldinger, dean, College of Science, Notre Dame University; P. D. Edwards, Department of Mathematics, Ball State Teachers College, Muncie; Fernandus Payne, Department of Zoology and dean emeritus, Graduate School, Indiana University, Bloomington; and Winona H. Welch, Department of Botany, DePauw University, Greencastle. Ex-officio members are C. L. Porter, president of the Indiana Academy of Science, Department of Biology, Purdue University; H. H. Michaud, state sponsor, Indiana Junior Academy of Science, Department of Forestry, Purdue University; and Walter Leckrone, editor, *Indianapolis Times*, Indianapolis.

R. W. LEFLER.

CARE, with the cooperation of Unesco, plans to help rebuild war-damaged libraries of Europe and Asia by the distribution of free scientific and technical books. The program, to be in operation by May 15, 1950, will be financed entirely by voluntary subscriptions from American organizations and individuals on the same basis as the CARE food and clothing distribution system. Selection of books will be made by a group of American librarians headed by Luther Evans, Librarian of Congress. The books will be sent to Austria, Belgium, Czechoslovakia, Finland, Italy, France, Greece, Korea, Japan, Norway, Holland, Poland, Great Britain, Western Germany, and the whole of Berlin.

The American Council of Learned Societies, which at one time or another has organized such projects as the *Dictionary of American Biography* and the *Linguistic Atlas of the United States and Canada*, is now sponsoring, jointly with the Social Science Research Council, publication of a weekly *Current Digest of the Soviet Press*. Selected contents of 40-odd Russian periodicals are translated, condensed, arranged by subject matter, and indexed. The material is presented without comment or elaboration. The two most important newspapers, *Pravda* and *Isvestia*, are received by air mail and reported about three weeks after their Moscow publication. The yearly subscription rate is $150 and single copies are $3.00. Recognized scientific or educational bodies subscribing at the basic rate may obtain additional individual subscriptions, for their own use or for staff members, at a special rate of $25 each. Inquiries may be addressed to the *Current Digest of the Soviet Press*, 1219 Sixteenth Street, N. W., Washington 6, D. C.

Recently Received—

Study Abroad: International Handbook of Fellowships, Scholarships and Educational Exchange, Vol. 1, 1948. Prepared by Unesco. Available through Publication Dept., Columbia University Press, New York 27, N. Y. at $1.00.

Dictionary of Guided Missile Terms: By the Committee on Guided Missiles of the Research and Development Board of the National Military Establishment. $1.00 paperbound, $2.00 clothbound from Public Affairs Press, Washington 8, D. C.

Radioautography by Tom McClure. In March 1949 issue of *Tracerlog*, issued by Tracerlab, 55 Oliver Street, Boston 10, Massachusetts.

Bibliography of Lobster Culture by Leslie W. Scattergood. Special scientific report 64, Fish and Wildlife Service, U. S. Dept. of Interior, Washington, D. C.

Prehistoric Art of the Aleutian Islands by George I. Quimbly. *Fieldiana—Anthropology*, Vol. 36, No. 3. Available from Chicago Natural History Museum, Chicago, Illinois at $.80.

Make Plans for—

Society of American Bacteriologists, 1949 annual meeting, May 16–20, Cincinnati, Ohio.

American Society of Plant Physiologists, New England section, May 20–21, University of New Hampshire, Durham.

American Association of the History of Medicine, annual meeting, May 23–24, Transylvania University, Lexington, Kentucky.

Science and Humanity

Detlev W. Bronk

Johns Hopkins University, Baltimore

TO COMPREHEND THE ROLE OF SCIENCE in American civilization, we must look beyond the scientist's desire for practical accomplishments. It is especially important that we understand this at a time when every man's life is profoundly affected by the scientist's actions and at a time when the national government has assumed a direct responsibility for training scientists with tax-contributed money.

The most powerful motive in science is curiosity. Few may doubt this, because curiosity is common to all men; it may seem unnecessary to comment further. I do so because, even in this age of science, curiosity is often considered a bothersome trait which has got us into a great deal of trouble from the days of the Garden of Eden to those of Hiroshima.

There is opposition to curiosity first in childhood. Only the most patient parent encourages its free development at the expense of his personal peace. Only the wisest of teachers discard the easy methods of didactic instruction to follow as counselors at the heels of students who freely satisfy their curiosity. Even in the scientific laboratory the student's curiosity is suppressed and the laboratory becomes a training ground for technical manipulation rather than a place for intellectual exploration. The present tendency to create an educational system which thus suppresses curiosity for the sake of "efficient" education robs modern civilization of the true scientists it needs.

Nor will the scientists' research flourish unless they have freedom to follow their curiosity. Against this there is now strong opposition. When science seemed rather unimportant, scientists were left pretty much alone to do as they wished—provided they were able to live. Nowadays science is recognized as necessary for human welfare and national survival. Because of this there are many who are willing to support science provided they can organize and direct the scientists' activities—about which they know but little. And there are those who believe that the usefulness of scientific research can be increased and its practical yield multiplied by putting many scientists to work under the controlled direction of a few.

There are problems and there are times which require that the individual freedom of the scientist be submerged in a common effort for the public good. But there is a grave danger that the present demand by publicists, industrialists, and public administrators for large scale scientific organizations may impede progress.

The most important discoveries of scientific research have come from the intellectual adventures of individual scientists. No one directed Newton to discover the laws of gravitation. No one organized Faraday's discoveries in electricity for the benefit of the modern electrical age. No one suggested to Roentgen that he discover X-rays for the diagnosis of human ills. No one instructed Niels Bohr to pave the way for atomic energy. Great scientific discoveries will usually elude direction and organization as surely as would the creation of great music or poetry, or sculpture or art. Much of scientific research is exploration of the unknown and I, for one, do not believe it is possible to direct the course of an explorer through unexplored territory.

Scientists have a second purpose, no weaker than curiosity, but more difficult to achieve. It is the desire to bring order out of chaos. Those who suddenly grasp the relation of previously unrelated facts, and thus see their relevance, experience a deep esthetic satisfaction. It is in that phase of scientific endeavor that facts and observations are formed into the structure of knowledge, which is the foundation for further discoveries. This is the role of the scientist's creative imagination. Without freedom and leisure for the play of his imagination, a scientist becomes only a fact-gatherer, dealing with the bare bones of science, unarticulated and unclothed with the flesh of meaning. As we plan our new age of science we shall do well to preserve an environment in which this freedom will be nurtured, despite the urgency of present needs. For it is unlikely that the scientists' imagination will often leap to a specified goal. A chaos of facts will seldom fall into an ordered, predetermined pattern, useful for a certain end.

Modern scientific endeavor must certainly be organized to provide the instruments for research and the combination of human skills necessary for diverse experimental tasks. But society will gain most from scientists if they are given freedom to observe, to experiment and think. Science is playing an important role in America's world-wide struggle for the freedom of the individual. In order that science may play that role well, the freedom of the scientists must be preserved against the regimentation of overstuffed organizations here at home. Despite the fantasies of scientific planners in and out of Russia, I should be surer of the social value of a mere score of scientists who are free to investigate and explain the facts of nature than of a thousand who are organized for the solution of a directed end.

In a democracy, however, it is not easy to justify such personal leisure and freedom, when most of the population must labor at routine tasks. "Why," asked a member of a Congressional appropriations committee recently, "should so few be supported to learn so much when so many know so little?" It is well to admit to such skeptics that some of the most important contributions of science to human welfare have no obvious practical usefulness. But let them consider how in a few generations we have been freed from the fear of natural forces that were mysterious and malevolent; how we have been freed from slavery to ignorance and superstition. At a time when science is prized for its contributions of instruments and weapons, of food and health and physical power and comfort, I would remind you that the pleasure which comes from an understanding of the beauties and forces of nature is a subtle value of science which extends the horizons of our intellect and enriches our lives.

Scientists are largely to blame for the fact that these intangible rewards of scientific investigation are not generally understood. One never hears musicians or sculptors or poets justify their role in society with the claim that they increase the physical well-being of their fellow men. Society values them, insofar as it values them at all, for the pleasure they give to life. Scientists, however, emphasize the material benefits of science because these are readily comprehended and accepted. In doing so, they misrepresent and belittle some of their major contributions to human welfare. Scientific research is one of the great adventures of the human mind. When the spirit of that adventure is generally understood, it will quicken the life and raise the hopes of people everywhere.

This is sufficient justification for the support of science as a major activity in society. But the effects of science do not end there. There is scarcely an aspect of American civilization which has not been shaped by scientific research and the applications of research. Our supply of materials comes from the laboratory as well as from nature. Industry depends upon power, scientifically created and controlled. Commerce requires swift transportation. Men live in cities heated and lighted and kept sanitary by scientific methods. Accordingly, the maintenance of American society requires a great army of scientifically trained men and women.

The characteristics of a continually developing American civilization are such that there is also an ever-increasing need for scientific investigation. The discovery of new metals makes possible the design of new machines, but that may require the development of new mathematical procedures. Atomic energy has created new elements which have made possible the discovery of new treatments for disease. In turn, such treatments require new methods for human protection against radiation. Each new scientific development creates further problems which require more study and research.

The demands for the fruits of science are further augmented by the recent war and by the present international hazards. This is an old story in the modern tempo, for the practical importance of science to warfare has long been recognized. Galileo and Leonardo were employed by their governments to improve artillery and the art of fortification. From that time onward, science has shaped the pattern of warfare until today science is recognized as one of the first lines of national defense. Scientists are required by the thousands for the training and operation of our armed forces. New weapons of aggression, forged by science, require of scientists new means for counteraction and defense.

THE NEW STATUS OF SCIENCE

Our culture, shaped by science and dependent upon science for its preservation, is now changing the pattern and status of science in America. Of that new status there are four aspects worthy of consideration.

The support of research. The first is a great increase in the money spent for research. During the year 1930, 166 million dollars were expended for scientific investigation and for its development towards practical purposes. By the year 1947 this amount had been increased to more than one billion dollars, which does not include expenditures in the field of atomic energy. Looking into the future, the President's Scientific Research Board has recommended that the amount should be two and a quarter billion dollars by 1957.

It is significant to recite additional figures. In 1930 the United States Government expended 23 millions for science, or 14 percent of the total. In 1947 the federal sum was 625 millions, more than 50 percent of the total national expenditure for scientific research. Obviously, those who are responsible for determining our national policies believe that the support of science is a governmental function.

But it is not surprising that they should meet strong opposition. On the one hand, federal support of science is opposed because of fear that science and scientists will be deprived of their freedom, and that the fruits of science will wither. On the other hand, there is also fear that the central government may gain from its vassal scientists too much power over the American people. To shrink from such dangers, however, is to doubt the virtues of American democracy.

If there be any field of activity which is the proper province of the national government, it is the encouragement of research. It is from scientific research that our citizens have the greatest promise of higher standards of living, better health, and security against the dangers of foreign aggression. Individuals, unaided, cannot reap the full benefits of science.

It would be unfortunate if the full responsibility for the support of science were relegated to the government. The integration of science into American culture requires that many individuals have the status of participating stockholders in the advancement of science. That this is increasingly so is a healthy characteristic of our social customs. University departments of teaching and research are supported by great numbers of individuals who are conscious of their responsible part in society. Countless industries are this year expending half a billion dollars on the discovery and development of new knowledge. Foundations for the furtherance of research now receive the benefactions of millions who, to the limits of their resources, follow the generous example of the wealthy few. Such are the National Foundation for Infantile Paralysis and the American Cancer Society.

The need for more scientists. The wise use of these increased financial resources requires a great increase in the number of scientists. This is the second characteristic of the new status of science.

It is not long since scientific research was an avocation of teachers and exclusive occupation of but a few isolated workers. Today universities, industries, and the government compete to fill needs for many thousands of scientific investigators. The number of scientists, technicians, and engineers has increased only one-tenth as fast since 1940 as has the expenditure for research and development. While the budget was increasing 335 percent, the supply of trained manpower expanded only 35 percent.

The technological and scientific progress of the nation and its operation depend upon less than one-half of one percent of our population; one-tenth of one percent of our population are actually engaged in scientific research and development; less than twenty-five thousand among our population of 150 million have had the advanced training for scientific research and teaching represented by the doctorate.

To meet these needs, the universities are straining every available facility. Private and public foundations and industries are contributing large sums for the education of scientists, and the government is initiating fellowship programs for the training of young men and women. The Atomic Energy Commission alone has appropriated two and one-half million dollars for such fellowships during the coming year or two. This is the development of a national resource of great importance.

No individual is endowed with all the qualities required for the pursuit of science, but there are vast, untouched reservoirs of human talent. For the advancement of science, as for the advancement of every phase of our civilization, we must learn to identify and to train those who are best qualified for a given social function, without regard for family fortune. Only thus are we likely to meet the specialized needs of a complex culture.

The spread of science. For several centuries the universities have been the nurseries and the homes of science. Now, as the number of scientists trained in the universities increases, more and more of the scientists migrate elsewhere.

The university began to lose its place as the only home of research about 1900, when the laboratories of the General Electric Company and of the Bell Telephone system were first established. Such industrial laboratories have grown and multiplied without a stop in sight, and now they have their numerous federal counterparts. This spread of science outside the universities is a third characteristic of its modern pattern.

It is well for the universities that this is so. A university is the ideal environment for thought and investigation and the spread of knowledge. The application of that knowledge to the practical problems of today is the function of other institutions which are being created for that purpose. The university scientists who withstand the pressure to solve practical problems of the present are the scientists who are free to pave the way for useful applications of the future.

The social responsibility of the scientist. Many of those who are devoted to the discovery of new knowledge have developed a concern for its social effects. I would name this uneasy sense of responsibility as a fourth characteristic of modern American science. It is natural that this should be so in troubled times of great change, for which science is in no small part the cause.

The critical needs for national survival marshaled our science to an extraordinary degree during this recent war. But the scientists' satisfaction in their achievements, which armed human courage, has been sobered by the realization that new forces of destruction were thus unleashed. Nor has the end of conflict been reassuring. The accomplishments of ages lie in ruins, and the hardly gained knowledge of nature is used by both, in the conflict between the good and the evil.

Science itself is neither good nor evil. It is "neither a benign nor a malignant activity of man." Science is a quest for knowledge and understanding, to be applied for human use as men desire. It is with such thoughts in mind that scientists feel an increasing obligation to participate in decisions as to how their discoveries and technical developments shall be used. But the fulfillment of this obligation will require scientists to acquire a knowledge of human affairs and of the motives which shape public policy. Even then scientists will most effectively participate in the wise use of science in public affairs by disseminating and understanding of science to those in public authority and to those who shape popular opinion.

Certainly it is desirable in a democracy that every citizen take an active part in the direction of government, to the limits of his abilities. Accordingly the growing social conscience of scientists is desirable. So, too, is the slowly increasing participation of scientists in the affairs of government. But our complex social structure requires that each citizen have a primary responsibility for some special task. Thus I return to the point that our future welfare requires that a goodly number of scientists be free to study nature without regard for the practical needs of the moment.

THE PLACE OF BASIC RESEARCH

The encouragement of scientific exploration or research—in contrast with the application of science—has not always been a characteristic of American culture. Commenting upon this a century ago, Alexis de Tocqueville attributed the emphasis upon immediate, practical values to the traits of a democracy, where, said he, "men . . . seldom indulge in meditation . . . and require nothing of science but its special applications to the useful arts and the means of rendering life comfortable." The observations of this distinguished observer of democracy in America were not far wrong, for fundamental research has flourished less here than in Europe. But his assumptions as to the reason for our emphasis on the practical aspects of science have been disproved by the recent development of basic science within our democracy. There are significant causes for this increased emphasis on fundamental research.

One of these causes is the spread of college education and the inclusion of science in the academic curriculum. To this I would add adult education in science by the radio and by scientific journalism which has reached high standards here in the United States. But as President Conant has emphasized in his book *On Understanding Science,* much of our education still deals with the results of science; there is little discussion of the methods and sequence of science. Until this defect is corrected we face a popular demand that scientists mortgage their future usefulness by concentrating their efforts on the practical application of past discoveries.

Despite the inadequacies of scientific education for the layman, many recognize that Michael Faraday's discovery of electromagnetic induction was necessary for the subsequent development of electric power and light and traction; that the botanical research of Gregor Mendel in the garden of a monastery paved the way for increased production by modern agriculture; that the theories of Willard Gibbs laid the foundations for much of our chemical industry.

Realizing this dependence of the practical upon that which is at first impractical, many intelligent citizens have supported basic research in universities, whence the discoveries flow into the stream of knowledge. The universities have thus assumed responsibility for exploring the endless frontiers of the nation.

In a democracy, it is appropriate that this national service should have been initiated by individuals. It is desirable that they should continue to accept that obligation. But it is also a proper responsibility of the national government which previously has been charged with the development, and protection for the future, of basic natural resources such as forests, water power, soil, and fisheries. Basic research, in contrast to applied research and technology, is not unlike such resources, for it provides new scientific knowledge of future value for our national welfare. This is the reason for support of university research by the Public Health Service and the armed forces and the proposed National Science Foundation.

In accepting such a partnership with the federal government the universities have assumed an obligation to preserve the freedom of scientists to seek "new trails to knowledge." Despite the present vigor of science, many who determine public policies see the desirability of applying a new discovery in the development of materials, machines, or weapons, in the treatment of disease or in the improvement of agriculture. Few have the faith to support abstract research, in the exploration of the unknown, for the benefit of future generations.

"If the Americans had been alone in the world," said De Tocqueville, "with the freedom and knowledge acquired by their forefathers and with the passions which are their own, they would not have been slow to discover that progress cannot long be made in the application of the sciences without cultivating the theory of them." We are not alone in the world, but we now occupy a position of preeminent power in world science. In our present position is it appropriate that we should benefit from the discoveries of scientists in other nations without contributing in return some discoveries to their benefit?

SCIENCE IS INTERNATIONAL

There can be no consideration of modern American science without regard to the international status of America. Our position in the world and the condition of the world depend upon science. If you suspect me of exaggeration, I suggest that you recall the influence of the atomic bomb on world thought and action.

The genesis of new ideas is catalyzed by the work and thought of others. Recognizing this, scientists have been among the first to realize the dependence of their work upon the efforts of those in other lands. Together with the traders for rare goods they have sought intellectual products and new discoveries wherever they were to be found. This desire for international cooperation derives from no unique nobility of spirit, but comes, rather, from the simple realization of the personal advantages that derive from a free exchange of ideas. If scientists are better prepared than others for the acceptance of the principles of world unity, it is because they have longer realized the benefits that come from such cooperation.

American scientists roam the free world for ideas and knowledge, and gladly receive their foreign colleagues who are free to come. Scientific missions to foreign capitals have been established for the exchange of information, and large sums have been allotted under the Fulbright Act for the interchange of scholars. Most significant, perhaps, is the role of the American government and American scientists in rebuilding the physical facilities for scientific research and teaching in foreign countries. Our nation is but one of the nations in a civilization that is based upon science. Lasting benefits of the unprecedented European Recovery Program will depend in large measure on the degree to which European science recovers its ability to meet the needs of a modern society.

Science increased in any free country will be "increased to the benefit of mankind in general." The observations of Galileo and Copernicus extended the intellectual horizons of no one national group; the discoveries of Faraday, the Englishman, have eased the labors of the citizens of many countries; a cure for disease discovered in Holland will be as beneficial to a sufferer in New York as it would be if it were made in Philadelphia. The future of American science and the welfare of the American people depend upon the rehabilitation of science throughout the world. Without such a scientific recovery, the civilization of other nations will become very different from the American culture.

Even now we delude ourselves when we talk of living in an age of science. The cultures of America and Western Europe are very different from those of other areas. If science expands in America without a corresponding development everywhere, there will be a further imbalance of cultures. There lies a grave danger to peace and stability.

The use of modern science gives a nation tremendous power and material advantages. Accordingly, it is natural in these days of international tension that those countries in which the practical aspects of science are developed to a high degree should be feared and suspected, and envied for the benefits they reap. This leads me to inject a comparison of American and Russian science. Excepting a few isolated, practical developments which would surely be used against us by an enemy, the discoveries of American scientists are free for all to hear and read. American scientists are encouraged to visit their colleagues overseas and to teach in foreign lands. Our laboratories and universities have been opened to foreign visitors coming by the thousands. Untold millions have been contributed to equip laboratories abroad. American science has done its part in rebuilding the international highways of science. This Russia has not done except in one week of self-gratifying celebration.

American science—in common with all phases of our culture—has accepted the responsibility to share its knowledge and its methods with all peoples, and especially with victims of poverty and disease and ignorance. Western science has an important role in shaping world cultures appropriate for these times.

SCIENCE CAN BUILD A BETTER WORLD

Modern cities with sanitation and communication and transportation are the products of science—but slums and noise and polluted air are symbols of our too great regard for the material aspects of civilization, and of too little regard for human life; the machine worker of mass production has not yet achieved a noble life of creation. Certainly the solution is not to abandon science, for even those who deplore most loudly the evils of our machine age would reluctantly return to a life of ceaseless labor, hardship, and disease. The same machines that build the slums can recreate the cities for human welfare. The planes that carried bombs on their missions of destruction are also available for the swift transportation of sick and wounded.

If I were to name another and one of the most admirable characteristics of American culture, it would be the gradual union of the physical and the human sciences, and more especially the union of the natural sciences with the social sciences and the humanities. In these troubled days the scientists can take little satisfaction in the social consequence of their discoveries. The material contributions of science alone do not create a rich and satisfying life. Nor do the intellectual values of science alone provide the spiritual satisfaction which men crave. Scientists are merely partners of many others in mankind's great endeavor. Science liberates men from the fear of unknown natural forces, frees men from grinding toil for mere survival, subdues pain, and cures sickness. Thus, science frees men to enjoy art and music and literature and the beauties of nature and religious faith. Science makes possible the enjoyment of much that science alone cannot give. Scientists are partners of those in other walks of life who seek to improve man's estate.

I should be blind to the status of modern American science if I did not recognize its critics and opponents. Many are torn between *fear* of new horrors science may add and *hope* that science will build a better world. Without science, which created the atomic bomb, we would still be defenseless against natural forces and disease. Would we rather be the *certain* victims of natural forces or *possible* victims of atomic energy misused by man? The question is: Do we have courage to understand the facts of nature and educate our fellowmen to use them for human welfare?

Science provides the building stones of a better world—but the world will be as we choose to make it.

This article was condensed from a chapter in the forthcoming book Changing patterns in American civilization *(the inaugural series of Benjamin Franklin Lectures delivered at the University of Pennsylvania during the spring of 1948). The volume is to be published May 20 by the University of Pennsylvania Press.*

The Enzymatic Reduction of the Retinenes to the Vitamins A

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The RETINENE$_1$, formed by the bleaching of rhodopsin, is converted to vitamin A_1 by a reaction for which reduced cozymase (DPN—H_2) serves as coenzyme (*10*). Retinene$_1$ is vitamin A_1 aldehyde (*2*); and the essential process is the transfer of two hydrogen atoms from DPN—H_2 to this molecule, reducing its carbonyl group to the primary alcohol group of vitamin A_1:

$$\underset{\text{retinene}_1}{C_{19}H_{27}CHO} + \text{DPN—}H_2 \xrightarrow{\text{retinene reductase}} \underset{\text{vitamin } A_1}{C_{19}H_{27}CH_2OH} + \text{DPN}$$

In the outer segments of the retinal rods this system is coupled with a second one which reduces DPN (*10*).

The reduction of retinene$_1$ has been followed in cell-free bries of whole retinas, in suspensions of isolated outer segments of rods (*10*), and in freshly prepared solutions of rhodopsin in aqueous digitonin (*3, 10*). Such fresh rhodopsin solutions lose the capacity to reduce retinene$_1$ within 3-4 hrs after preparation. This is because they lose their DPN—H_2 by the action of an enzyme widespread in animal tissues and particularly active in brain, to which retina is closely related (*4*). Rhodopsin solutions left at room temperature for 18 hrs, which have entirely lost the ability to reduce retinene$_1$, are reactivated by addition of new DPN—H_2. The apoenzyme, retinene reductase, is therefore relatively stable; the inactivation of fresh rhodopsin solutions is due to the loss of the coenzyme.

The retinene reductase system has now been fractionated into its components, all in true solution. Two components are in a satisfactory state of purity and chemical definition: the coenzyme, DPN—H_2, prepared by Ohlmeyer's method (*5*); and the substrate, synthetic retinene$_1$, prepared by the chromatographic oxidation of crystalline vitamin A_1 on manganese dioxide (*2, 8*).

The apoenzyme has not yet been isolated as a pure substance, but it has been prepared free of the other components. It is extracted with dilute salt solutions from homogenized frog or cattle retinas, forming a

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[1] This investigation has been supported in part by a grant from the Medical Sciences Division of the Office of Naval Research. I should like to acknowledge the expert and devoted assistance of Mr. Paul K. Brown in many of the experiments.

clear, almost colorless solution. From this it is precipitated by half-saturation with ammonium sulfate and may be redissolved without loss of activity. It can also be dialyzed in a Visking membrane for as long as 16 hrs against M/15 phosphate buffer (pH 6.8; 5° C) without harm. It is destroyed by heating at 100° C within 30 sec. Its pH optimum lies at about 6.5.

Retinene$_1$ is a typically fat-soluble substance and was originally introduced into our enzyme system with the aid of digitonin, with which it forms a water-soluble complex. This step proved to be unnecessary, however, since the retinal extracts which contain our apoenzyme take up retinene$_1$ directly. This in itself is evidence that retinene$_1$ couples with water-soluble substances from the retina. Primarily it attaches to protein, for it is precipitated from such solutions with the protein fraction.

It has been known for some time that in the product of bleaching rhodopsin *in solution,* retinene$_1$ remains loosely coupled with protein (*7*). In this condition it displays the properties of a pH indicator. Synthetic retinene$_1$ does not exhibit this behavior; nor does natural retinene$_1$ after adsorption and elution (*8*). Ball, *et al.* (*1*) have now shown that the pH indicator property is characteristic of retinene$_1$ in the coupled condition; synthetic retinene$_1$ acquires this property on condensing spontaneously with certain proteins, amino acids, and aromatic amines. Indeed, further evidence that the synthetic retinene$_1$ taken up by our apoenzyme solutions is coupled in this manner is that it has become a pH indicator. It has in fact taken on the properties generally associated with the product of bleaching rhodopsin in solution.

It is of some importance to note that retinene$_1$ is not restricted to a single complex in its retinal associations. Rhodopsin and retinene reductase are two distinct proteins. Retinene$_1$ normally originates on rhodopsin protein, but it must migrate onto the apoenzyme preparatory to its reduction. Such migrations of retinene$_1$ and changes of the molecules with which it is coupled must play an important part in retinal metabolism.

In the rods of fresh-water fishes, lampreys, and some amphibia, rhodopsin is replaced by porphyropsin (*9*). The bleaching of porphyropsin forms retinene$_2$. This is reduced to vitamin A$_2$ by an enzyme system entirely comparable with that which reduces retinene$_1$ in cattle and frogs.

This system may be assembled from the following components: the apoenzyme, contained in a saline extract of homogenized fresh-water fish retinas (sunfish, yellow perch); as coenzyme, DPN—H$_2$; and as substrate, synthetic retinene$_2$, prepared from vitamin A$_2$ by chromatographic oxidation on manganese dioxide (*8*).

The apoenzyme from fresh-water fishes, however, reduces retinene$_1$ as effectively as it does retinene$_2$. Conversely, the frog retinal apoenzyme reduces retinene$_2$ as well as retinene$_1$. There is no reason at this time to designate the apoenzyme differently in the rhodopsin and porphyropsin systems, since it is capable, in cooperation with DPN—H$_2$, of reducing either retinene to the corresponding vitamin A. It can be referred to simply as retinene reductase.

It was remarked above that retinal homogenates and extracts contain an enzyme which destroys DPN. In our fresh-water fish extracts this destructive action was so intense as to block the reduction of retinenes even when DPN—H$_2$ had been added. It is essential to protect the coenzyme in such preparations and it is advantageous to do so also in extracts of frog and cattle retinas.

Cozymase can be protected by adding nicotinamide to the enzyme system, in a final concentration of about 0.03 molar (*4*). It has been reported that α-tocopheryl phosphate (vitamin E phosphate; 0.0015 molar) similarly protects DPN (*6*). This last reagent has another beneficial effect on our system—as an antioxidant it inhibits the oxidation of the vitamins A formed as products of the reaction.

The retinene reductase system as most effectively assembled therefore reveals an extraordinary degree of vitamin interaction *in vitro.* The main process presents the novel phenomenon of one vitamin regenerating another, in that the DPN—H$_2$ which reduces the retinenes to the vitamins A, contains as its central component the antipellagra factor, nicotinamide, a member of the vitamin B complex. While so engaged, DPN—H$_2$ is protected from cleavage by the presence of free nicotinamide. The latter is aided in this action by vitamin E phosphate, which simultaneously protects the vitamins A formed in the main reaction from oxidative destruction.

A complete account of these experiments will appear in the *Journal of General Physiology.*

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TECHNICAL PAPERS

Sympathetic Ganglion Cells in Ventral Nerve Roots. Their Relation to Sympathectomy

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Surgical procedures designed to bring about sympathetic denervation of a part of the body have been based on the assumption that all peripheral sympathetic conduction pathways traverse the sympathetic trunks. If this assumption were correct, sympathetic trunk extirpation or section of the corresponding white communicating rami would result in interruption of all sympathetic pathways in the affected area, and insure its complete sympathetic denervation.

Failures to achieve complete sympathetic denervation, particularly of the extremities, by extirpation of the appropriate segments of the sympathetic trunks or by section of the white communicating rami in the appropriate segments have suggested the possible existence of peripheral sympathetic conduction pathways which do not traverse the sympathetic trunk. Such pathways could be postulated on the assumption that some embryonic nerve cells, in their displacement from the neural tube, have failed to reach the primordia of the sympathetic trunks and have been differentiated into ganglion cells in the ventral nerve roots, or adjacent to them, where they have become synaptically connected with preganglionic fibers which either do not extend into the sympathetic trunk or give off collaterals to the ganglion cells in question.

Small ganglia located in communicating rami in the lumbar (*1, 2, 7*), the cervical, and the upper thoracic segments (*5*) have been described. Most of them appear to be located in gray communicating rami. Occasional ones have been described as located adjacent to a ventral nerve root, probably in a white communicating ramus. Wrete (*7*) and Skoog (*5*) have suggested the possibility that such ganglia may be a factor in the residual activity following sympathectomy in some cases.

In examining a series of human bodies, we have observed small ganglia imbedded in ventral nerve roots or adjacent to them, usually at the site of origin of a white communicating ramus, particularly in the first and second thoracic and the first and second lumbar segments. Small ganglia have also been observed in communicating rami, particularly gray rami. In the present report only those in ventral nerve roots or adjacent to them will be considered. Most of them are small. Among the larger ones, an individual ganglion may comprise in excess of 20,000 ganglion cells. In appropriate histologic sections, fibers of the ventral nerve root may be traced into the ganglion. Fibers may also be traced distalward from it in the spinal nerve. The possibility that the axons of some ganglion cells in such ganglia extend into the sympathetic trunk is not precluded, but most of them appear to extend distalward in the spinal nerve without traversing the sympathetic trunk. A nerve with sympathetic ganglion cells located in its ventral root or adjacent to it, therefore, includes direct sympathetic conduction pathways which are independent of the sympathetic trunk and which, consequently, are not interrupted by extirpation of the corresponding sympathetic trunk or section of the white communicating rami which join them.

The anatomic demonstration of sympathetic conduction pathways which involve synaptic connections in ventral nerve roots, and which do not traverse the sympathetic trunk, affords a more satisfactory explanation than has been possible hitherto for most of the failures to achieve complete sympathetic denervation by sympathectomy, in the absence of faulty operative technic. The frequency with which direct sympathetic pathways occur is indicated by the frequency with which residual sympathetic activity can be demonstrated following interruption of all the pathways which traverse the sympathetic trunk. In an extensive series of patients who had been subjected to extirpation of the sympathetic trunk from the eighth thoracic to the third lumbar segments inclusive, Ray and Console (*4*) demonstrated sympathetic activity, particularly in the twelfth thoracic and the upper three lumbar dermatomes, in every case.

Resection of the ventral roots of the second and third thoracic nerves has been carried out, particularly by Smithwick (*6*), in preganglionic sympathectomies of the upper extremities. The advantage of this procedure probably depends on interruption of direct sympathetic pathways in which the ganglion cells are located in relation to the ventral root of the second thoracic nerve. Since the ganglion cells associated with the ventral roots of lumbar nerves appear to be located mainly in the first and the second lumbar segments, section of the ventral roots of the first and second lumbar nerves, in addition to extirpation of the lower two thoracic and the upper three lumbar segments of the sympathetic trunk, probably would insure complete sympathetic denervation of the lower extremity in most cases.

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Inactivation of Enzymes by Visible Light in the Presence of Riboflavin

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During a study of the mechanism of light action on plant growth (*2*, *3*) it was found that riboflavin can sensitize the photo-oxidation of various indole-containing compounds, including the plant growth hormone indoleacetic acid and the amino acid tryptophane. Such photo-oxidations proceed rapidly at low concentrations of riboflavin (0.1–10 γ/cc) and at moderate light intensities. Because tryptophane is normally present as a constituent of proteins, it seemed desirable to investigate the possibility that riboflavin could have a similar effect upon the tryptophane of protein molecules.

For convenience in determining the effectiveness of our photoinactivation system we decided to use various enzyme preparations as experimental proteins. In such experiments we have invariably found that enzymes suspended in riboflavin solutions are rapidly inactivated by visible light. Thus urease is completely inactivated in 2½ hr, α-amylase in 6 hr and tyrosinase in 17 hr. Since no enzyme which we have investigated has proved insensitive to this photoinactivation procedure, the phenomenon seems to be quite general. In this paper, we shall report in some detail the results of our experiments with the α-amylase of malt diastase.

The α-amylase investigated was present in Merck diastase of malt. Preliminary investigations demonstrated that the enzyme reacted most rapidly in the pH range 5.9–6.6. M/15 pH 6.1 phosphate buffer was therefore employed as standard throughout these experiments.

The malt diastase was made up into a 1% stock solution which was stored under toluene in the refrigerator. Such stock solutions were found to retain full activity for at least 1 week. Immediately prior to use, the enzyme was diluted tenfold. For the study of the reaction, 1 cc of diluted enzyme was mixed with 4 cc of buffer and then with 5 cc of previously boiled 1% soluble starch. At desired time intervals, 1-cc aliquots of the reaction mixture were removed and added with vigorous stirring to 10 cc of $KI.I_2$ solution. The stock solution of this reagent was 2% KI, with enough resublimed iodine crystals added to give a distinct yellow color. The stock was diluted 1:100 immediately prior to use.

The blue color resulting from mixing the 1-cc aliquot of the reaction mixture with 10 cc of the 1:100 $KI.I_2$ was found to be quite stable and convenient to measure. All determinations of color intensity were made in a Klett-Summerson photoelectric colorimeter, using a red filter. Colorimeter readings at zero time were approximately 230; these readings fell linearly to zero in approximately 30 min at room temperature (23° C).

In order to compare the activities of control and experimental enzyme preparations, it was necessary to adopt some arbitrary unit of activity. For this purpose, we determined the time *t* necessary for complete disappearance of the starch color, and then expressed enzyme activity as 1/*t*. In almost all cases, *t* was directly determined, but where partially inactivated enzymes were reacting very slowly, *t* was approximated by extrapolation.

To determine whether riboflavin could sensitize the photoinactivation of α-amylase, 1 cc of the diluted enzyme was mixed with 1 cc of pH 6.1 phosphate buffer either lacking (control) or containing (experimental) 100 γ of the riboflavin (Rbf). Tubes were either stored in the dark or were illuminated by 400 ft candles of fluorescent white light for 1 hr. At the end of this time, 3 cc of buffer and 5 cc of 1% soluble starch were added to each tube and aliquots removed for colorimetric analysis every 10 min. In order to insure that differences in activity would be due to the pretreatment of the enzyme and not to riboflavin effects on starch hydrolysis itself, riboflavin was incorporated into the buffer added to enzymes not previously so treated. The results of such an experiment are shown in Table 1. It is clear that visible light or riboflavin applied separately have but slight effect on the rate of enzyme action, but that illumination of enzyme solutions containing riboflavin result in a marked reduction of enzyme activity.

TABLE 1

EFFECT OF VISIBLE LIGHT ON ACTIVITY OF AN ENZYME SENSITIZED BY RIBOFLAVIN*

Contents during pretreatment	Illumination during pretreatment	Starch—$KI.I_2$ color after 10 min	20 min	30 min
1 cc enzyme 1 cc buffer	dark	118	64	0
1 cc enzyme 1 cc buffer containing 100 γ rbf.	"	134	71	12
1 cc enzyme 1 cc buffer	400 ft candle fluorescent white light	127	79	16
1 cc enzyme 1 cc buffer containing 100 γ rbf.	"	157	135	112

* Temp = 23° C, pretreatment period = 1 hr. After pretreatment, all tubes were made up to contain 1 cc enzyme, 3 cc buffer, 1 cc buffer-riboflavin and 5 cc 1% starch solution.

We next endeavored to arrive at some understanding of the nature and kinetics of the inactivation reaction. For this purpose a series of tubes was prepared in the dark room, necessary illumination for the operations being supplied by a 7½ W ruby-red bulb. Into each tube was placed 1 cc of enzyme and 1 cc of buffer containing 100 γ of riboflavin. The tubes were then carried into the laboratory and exposed to the light. At various intervals, tubes were removed from the light rack and returned to the dark room. At the end of 17 hr, all exposed tubes were tested for residual enzyme activity. To each was added 3 cc of buffer and 5 cc of 1% starch solution. Aliquots were then removed at frequent intervals, and the time, *t*, necessary for complete disappearance of the starch color was determined. Data are presented in Table 2. A plot of the log of relative enzyme activity against duration of preillumination yielded a straight line (Fig. 1). This indicates that the inactivation follows the time course expected for a first-order reaction and probably involves a ''one-hit'' mechanism.

TABLE 2

Effect of Duration of Illumination on Activity of α-Amylase Sensitized by Riboflavin

Duration of exposure to light	Time (t) in min to complete disappearance of starch	$\frac{1}{t}$	Relative activity
0	34	.0294	100
10 min	39	.0256	87
30 min	48	.0208	71
1 hr	66	.0152	52
2 hr	114	.0088	30
3 hr	220	.0045	15
4 hr	360	.0028	10
5 hr	582	.0017	4
17 hr	∞	0	0

Subsequent experiments with antibodies and with bacteriophage have demonstrated that these types of proteins are also rapidly photoinactivated in the presence of riboflavin.

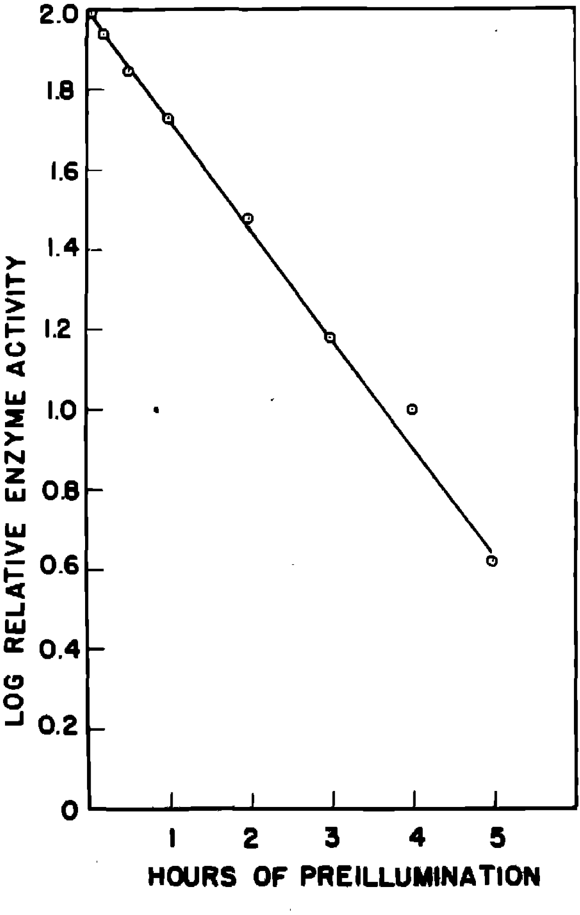

Fig. 1. Effect of duration of preillumination upon the inactivation of α-amylase.

As early as 1879 (*1*) it was reported that sunlight, especially the blue-violet wavelengths, could cause the aerobic photoinactivation of a crude enzyme preparation. Von Tappeiner (*6*) (see also other references in the review by Schomer [*5*]) later reported that the addition of fluorescent dyes such as eosin greatly accelerated such photoinactivation. It is perhaps not surprising, therefore, to find that riboflavin, which is strongly fluorescent in blue light, produces a similar effect.

Our investigations (unpublished) on the relation of light intensity and riboflavin concentration to the rate of photoinactivation strongly indicate that this type of reaction could proceed *in vivo*, at least in green plants. This reaction may therefore be of some importance in one or more of the light-growth reactions of plants such as phototropism, photoperiodism, and the light inhibition of internode growth.

It is also interesting to note that numerous investigators (*4*) have attributed the effects of ultraviolet irradiation of enzymes to a specific absorption by tryptophane. Since riboflavin is known (*3*) to cause the photoinactivation of tryptophane, this reaction may provide a mechanism whereby visible light produces the same sort of effect on enzymes as ultraviolet light.

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A New Method for Isolation and Purification of Mammalian Striated Myofibrils[1]

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The following method has been devised for isolating large numbers of mammalian skeletal and cardiac myofibrils in highly purified form without modifying their microscopic structure or reactivity to adenosine triphosphate.

The method with slight variations is suitable for isolation of myofibrils of man, rabbit, dog, and guinea pig. The present discussion is concerned principally with the isolation of skeletal myofibrils of rabbits and properties of the segregated fibrils.

A block (25 × 25 × 10 mm) of living white muscle from the anterior thigh was rapidly frozen and cut with a cold

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[1] This research was aided by a grant from the Otho S. A. Sprague Memorial Fund.

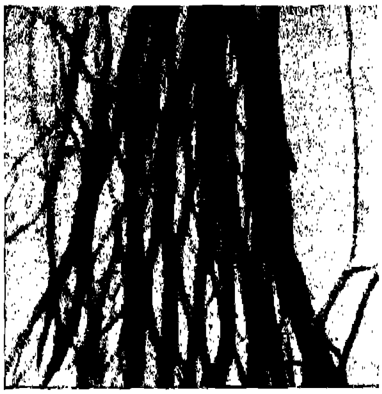

FIG. 1.

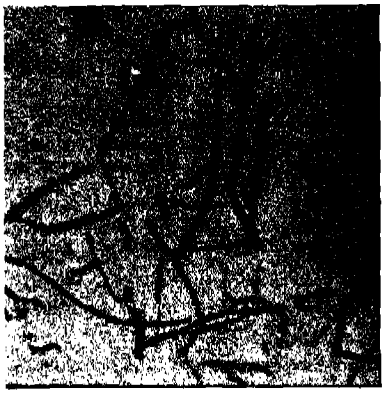

FIG. 2.

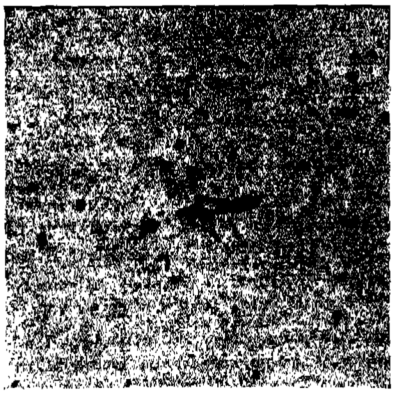

FIG. 3.

microtome into sections, 15 μ in thickness. The sections were transferred to 250 cc of potassium phosphate and citric acid buffer solution (pH 7, ionic strength 0.25, temperature 0° C) containing 5.0 cc of a 0.4% filtered solution of commercial trypsin. Sample sections were removed periodically, mounted under a cover slip and studied microscopically. When gentle pressure on the cover slip was sufficient to rupture the sarcolemma (Fig. 1) and permit the escape of segregated myofibrils (usually after 30–45 min of tryptic digestion), the sections were filtered from the enzyme buffer solution, washed, and resuspended in a potassium phosphate and citric acid buffer solution (pH 6.4, ionic strength 0.25). This suspension was agitated in a Waring blender for 5–10 sec. During this treatment the sarcolemma ruptured and myofibrils were released. This crude preparation was purified by repeated washing and centrifugation at 0° C. The final suspension of myofibrils formed a white flocculent mass containing only microscopic traces of collagenous and cellular debris. The myofibrils, usually single, but occasionally adherent in groups of two or more, were elongated, birefringent rods measuring 0.25–1.2 μ in diameter in fixed preparations. ''A'' and ''I'' disks were distinct but ''Z'' lines were rarely seen (Fig. 2).

The solubility of the myofibrils was studied microscopically. They promptly dissolved in 5–10 volumes of a cold aqueous alkaline solvent (0.5 M potassium chloride, 0.03 M sodium bicarbonate) yielding a viscous solution showing birefringence of flow. In cold buffer solutions (pH 1–12, ionic strength 0.15), the myofibrils dissolved in the ranges: pH 1–4, and pH 10–12.

The influence of ionic strength and potassium chloride on the solubility of myofibrils was determined by adding potassium chloride to cold phosphate and borate buffer solutions (pH 6–11, ionic strength 0.05). The myofibrils dissolved in solutions (ionic strength 0.2) alkaline to pH 10; in solutions (ionic strength 0.3) alkaline to pH 8; and in solutions (ionic strength 0.5) alkaline to pH 6. Comparable results were obtained with potassium phosphate buffer solutions of varying ionic strength and pH.

When isolated myofibrils under direct microscopic observation were immersed in a solution (0.075%) of adenosine diphosphate and triphosphate at room temperature, they spontaneously and rapidly contracted into small round masses. This contraction was not reversible (Fig. 3).

Paleocene and Eocene Strata in the Bearpaw Mountains, Montana[1]

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The dark, rounded features of the Bearpaw Mountains, rising some 4,500 ft above the surrounding plains in north central Montana, can be seen readily from railroad or highway between Chinook and Havre or between Havre and Big Sandy. Centennial Mountain, the most conspicuous land form in the western part of the mountains, has the appearance of a sleeping bear. This resemblance and the Indian legend associating the mountain with a prominent adjacent butte near Box Elder provided the original name ''Mountain of the Bear's Paw.'' The softened contours of the Bearpaws are in large part the result of normal differential erosion of diverse rocks plus the effect of a forest mantle consisting of Douglas fir, ponderosa and lodgepole pines, cottonwood, aspen, white birch, service berry, cherry, hawthorn, rose, raspberry, alder, and dogwood—in brief, an outpost of the Rocky Mountain flora, 150 miles distant.

In this Bearpaw region irruptive magmas (now stocks, plugs, dikes, sills, laccoliths, flows, and agglomerate piles) in the Tertiary penetrated and at times overflowed a terrane originally of nearly horizontal sedimentary strata of late Mesozoic and early Tertiary age. These sedimentary formations exposed in and around the mountains are now tilted and faulted, with fault blocks of widely differing ages abutting against one another (7). The resulting complex geologic relations are unfortunately somewhat obscured in large areas by glacial deposits and bench gravel. The junior author began his geologic studies in 1937 with particular emphasis on the petrology of the mountains (3, 4, 5), but for a few days in 1940 and in the period August 13–22, 1948, the senior author joined in the field study of specific stratigraphic problems where paleobotanical experience was needed.

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[1] Published by permission of the Director, U. S. Geological Survey.

The identity of the coal-bearing strata several hundred feet stratigraphically above the marine Bearpaw shale (Cretaceous) in the southern part of the mountains has been subject to controversy for many years. These beds were identified in 1912 and 1914 as Fort Union by F. H. Knowlton for Pepperberg (6) and Bowen (1). In 1925, Reeves (7), on the basis of lithologic similarity to rocks of other regions with which he was familiar, designated the strata as Lance rather than Fort Union. In new collections recently made by the writers from carbonaceous shales and clays at the Ideal, Flatness, Blue Pony, Nygaard, Mackton, N L Ranch, and Nielsen Ranch coal mines and prospects are the following plants: *Glyptostrobus dakotensis*, *Sequoia* (*Metasequoia*) sp., *Cercidiphyllum arcticum*, *Aralia notata*, *Viburnum antiquum*, and *Viburnum asperum*. This is clearly a Fort Union (Paleocene) assemblage and supports the earlier conclusions of Knowlton and Bowen.

The Fort Union formation in the Bearpaw Mountains is characterized by brownish yellow sandstones and coal beds. The total thickness of the formation is not known but the portion exposed is in excess of 200 ft. The Judith River formation (Cretaceous), stratigraphically underlying the Bearpaw shale, also contains coal beds mined and prospected in the northern part of the mountains. The coal of the Judith River formation is, however, generally poorer in quality than that of the Fort Union formation. Associated carbonaceous shales and clays contain a diagnostic species of *Araucarites*. Several invertebrates also distinguish the Judith River formation.

Between the Fort Union formation and the Bearpaw shale is a coal-barren series of green-gray sandstones and thin shale beds. This section, in excess of 600 ft, is probably equivalent to the Fox Hills and Lance sequence that represents the uppermost Cretaceous sedimentation in this region.

Stratigraphically overlying the Fort Union formation, or faulted against it and older beds, is a sedimentary formation at least 450 ft thick, characterized in the basal part by a variegated sequence of sandstone and siliceous shale and in the upper part by sandstone and conglomerate. The dominant colors in the formation are red, purple, grayish yellow, and grayish green. A carbonaceous shale in the lower part of the formation yielded the floating fern *Salvinia preauriculata*, a diagnostic plant for the early Eocene in the Rocky Mountains and Plains region. The variegated beds yielded fragmentary remains of vertebrates (gar pike scales, turtles, and mammals). Of particular significance are a small, toothless, unidentified mammalian jaw and one somewhat worn molar tooth, identified by Dr. C. L. Gazin, of the U. S. National Museum, as resembling that of *Homogalax*, a tapirlike Eocene creature. Lithologically, the variegated sequence here assigned to the Wasatch formation, strikingly resembles the Wasatch in the Bighorn and Powder River Basins, Wyoming, where *Eohippus*, *Coryphodon*, *Diacodexis*, and many other Eocene mammals have been found.

The conglomerate in the upper part of the Wasatch formation in the Bearpaws represents boulder-channel deposits by streams of high gradient and is composed largely of quartzite like that of the Belt series (pre-Cambrian) in the Rocky Mountains. Other rocks present are limestone (Paleozoic), extrusive or intrusive porphyry, serpentine, and diorite-gabbro. None of the boulders is of local Bearpaw Mountain origin. Many of the boulders display pressure scars and accompanying fractures recemented by matrix sand, indicating effect of adjustment stresses attending or immediately following deposition of the boulders. Subsequent jointing of the indurated boulder bed produced secondary fractures in many of the boulders. Similarly bruised and fractured pebbles and boulders in conglomerate in Arizona were described by Campbell (2).

Uncomformably overlying the Wasatch formation in the southern Bearpaws are volcanic deposits of different compositions and ages. The oldest of these, principally latite, contains in the basal part tuffaceous beds that are plant-bearing. Remains of the following plants were identified: *Equisetum* sp., *Platanus* sp., *Aralia* sp., *Chaetoptelea* sp., *Laurus* sp., *Hydrangea* sp., and *Persea* sp. Some of the leaves are represented by only one fragment and consequently the species cannot be determined definitely at this writing. The general aspect of the assemblage, however, is that of other early or middle Eocene floras, in particular those of Yellowstone National Park and the Wind River Basin of Wyoming, but better collections may conceivably indicate a somewhat younger age.

The Eocene volcanic beds are of local Bearpaw Mountain origin. Their eruption was preceded by intrusions of monzonitic intrusive rocks and followed by a great variety of intrusive and extrusive igneous rocks, principally of alkalic affinity and presumably also of Eocene age.

It is evident that regional sedimentation in north central Montana continued into Eocene time, when it was interrupted locally by uplift and igneous activity. The Paleocene and Eocene formations, preserved in a few down-faulted blocks in the Bearpaw Mountains, were probably at one time continuous with formations of similar age now exposed in distant parts of Montana, Wyoming, and the Dakotas, the intervening portions having been removed by erosion. Thus, in the plains area of north central Montana, vertical fault displacements of about 2,000 ft preserved early Tertiary strata in downthrown blocks, and erosion in uplifted structures removed a stratigraphic section exceeding 5,000 ft in thickness.

In summary, the evidence here submitted establishes the existence in the Bearpaw Mountain region of coal-bearing strata of the Fort Union formation (Paleocene); of variegated and conglomeratic strata of the Wasatch formation (early Eocene); and of volcanic rocks of probable middle Eocene age. The first settles an old controversy; the second reveals strata not hitherto reported and dated; and the third restricts the probable date of the beginning of volcanic activity in the region.

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Sex Differences in Blood Pressure of Dogs

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There have been numerous reports in the literature dealing with blood pressure values in presumably normal men and women. Recently Boynton and Todd (*1*) reported blood pressure determinations on 75,258 students at the University of Minnesota—truly a formidable number. There were 43,800 men and 31,458 women in the various age groups studied. The mean systolic blood pressure for men and women of all ages was 122 and 111 mm of Hg respectively; the diastolic was 74.5 and 69.7 mm of Hg respectively. In every age group, save that over 40, the mean systolic pressure in men significantly exceeded that in women. Other workers have reported similar differences in blood pressure between the sexes, although a minority of authors believes that there is no significant difference.

It was thought worth while, from the standpoint of comparative physiology, to study the problem in the dog, to see if significant differences in blood pressure exist there between the sexes. It was deemed impracticable to determine the blood pressure in dogs by the indirect method, that is, by use of the inflated cuff. Therefore, 147 anesthetized dogs were used. Sodium barbital was the anesthetic chosen and was given either intravenously or intraperitoneally (300 mg/Kg). In the latter instance it was given 60 to 90 min prior to the blood pressure determinations. Under surgical anesthesia, a cannula was inserted into the carotid artery and the blood pressure recorded by means of a mercury manometer. After the normal blood pressure readings had been ascertained, these animals were used for other experimental purposes, before recovering from the surgical anesthesia.

Table 1 shows the results obtained. The male dogs had, on the average, a blood pressure of 9 mm Hg higher than that of the females. This difference is also reflected in the median values: 132 mm Hg for the males; and 124–125 for the females.

Tatum and Parsons (*3*) in 1922 called attention to the desirability of using barbital as an anesthetic agent for dogs, since it had the significant property of preserving an approximately normal blood pressure. As far as known, furthermore, the barbiturates have the same effect on male as on female dogs, in contradistinction to the action of some of them on male and female rats. Our results are not entirely comparable to those of Hamilton (*2*), who found no significant differences in blood pressure values between the sexes in street dogs. His method differed from ours, in that he used light doses of morphine sulfate and in that our experiments were performed on unselected dogs. It was impossible for us to control the age factor, except for the fact that only adult dogs were used.

TABLE 1

Sex Differences in Blood Pressure in Dogs

Blood pressure range mm of Hg	Number of males	Number of females	Male average mm of Hg	Female average mm of Hg
60–79	0	1	. . .	60
80–99	3	6	91	92
100–119	12	24	111	110
120–139	28	24	129	128
140–159	14	23	150	147
160–179	9	2	165	166
180–199	1	0	190	. . . .
60–199	67	80	134	125*
	Standard	Deviation:	21.5	20.7

* The difference (9 mm of Hg) between blood pressure for male and female dogs has a *t* value (according to Fisher) of 2.5803; for this value p is 0.011. The standard error of this difference is 3.50.

It is to be concluded from our data that in adult barbitalized dogs, males have a significantly (p = 0.011) higher mean systemic blood pressure than females by 9 mm Hg.

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A Metabolism Cage for Small Animals

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The cage designed by Henriques and Hansen (*3*) for the quantitative collection of urine and described by them in 1904 has undergone numerous modifications. Some of these have simplified the form and increased the ruggedness (*1, 2*) while others have overcome specific problems in quantitative collection (*4*). The modification described below falls into the last category and was designed to isolate the feces so that subsequent specimens of urine could not contact them. The value of this adaptation is obvious when one wishes to analyze the urine for a compound which may be present also in the feces.

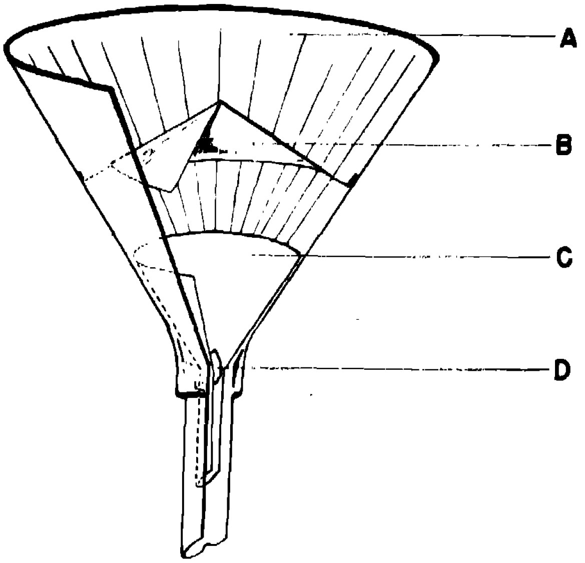

FIG. 1

The essential features of the new separating unit are shown in Figs. 1 and 2. A 3-in funnel (C) placed inside of a 10½-in ribbed funnel (A) collects the feces which either roll down the sides of (A) or hit the conical shield (B) and are deflected first to (A) and then to (C). The rim of the smaller funnel should be thin, approximately 1/32 in. A glass plug (D) prevents feces from entering the neck of funnel (C). Funnel (A) is a ribbed Mooney air vent model, preferred because of its small neck. Shield (B), detailed in Fig. 2, completely covers funnel (C) and deflects all urine to the surface of (A) where it runs between the funnels into a collecting graduate. This shield is a right circular cone with a slant height of 3⅛ in and a diameter of 5¼ in at the base. It is supported by three rods 3/32 in in diameter and bent at such an angle that the terminal ½ in rests snugly on the sides of funnel (A). That portion of the rod which contacts the funnel is covered with rubber to prevent slipping. The cone is made of copper coated with tin and covered with a thin uniform layer of paraffin.

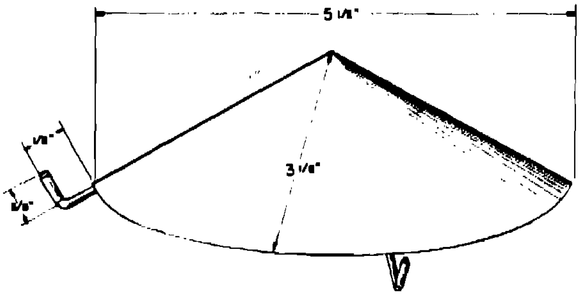

FIG. 2.

This assembly (Fig. 1) is supported by a 6-in iron ring anchored to a large ring stand. The animal is confined in a cylindrical cage 8½ in in diameter and 9 in high, made from ¼-in wire mesh. This cage is anchored to the same stand by an L-shaped iron rod which supports it in funnel (A) so that its bottom is ½ in below the rim of the funnel and ½ in above the vertex of cone (B).

Twenty of these units have been in use for more than two years and satisfactorily accomplish the purpose for which they were designed.

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Penicillin in Relation to Acid Production in Milk by Starter Cultures Used in Cheddar Cheesemaking[1]

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The extensive use of penicillin in control of bovine mastitis has resulted in warnings to cheese factory milk producers (*1*) that sufficient penicillin may be carried over into the milk to interfere with normal development of acid by starter culture organisms when added to this milk in manufacturing Cheddar cheese. Slowness of acid production in the vat extends the time of manufacturing appreciably and results usually in low quality cheese.

The problem was studied by inoculating mixed or single strain starter cultures at the rate of 3% into pasteurized milk, dispensing 100-ml amounts into bottles, and adding a known amount of penicillin (ranging from 10,000 to 0.05 units) to each bottle. The bottles were incubated in a water bath at 98° F; 9-ml aliquots were removed at hourly intervals for titration with 0.1 N NaOH using phenolphthalein as indicator. Complete inhibition of acid production was obtained with 100 units, and virtually complete stoppage with 50 units penicillin per 100 ml milk. Partial inhibition was evident with 0.5–5.0 units in both the mixed and single strain starter series.

Penicillinase[2] when added at the rate of 0.02 mg per bottle completely canceled the effect of 5–10 units of penicillin and permitted appreciable acid production in the presence of 100 units of the antibiotic. The development of starter cultures composed of penicillin-resistant strains of lactic streptococci is another possible means of overcoming this difficulty. Cysteine did not do this even when added at the rate of 1–10 mg per bottle. Pasteurization of milk containing varying amounts of penicillin failed to inactivate the antibiotic.

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[1] Contribution No. 275.

[2] Kindly supplied by Miss E. Campbell, Laboratory of Hygiene, Department of National Health and Welfare, Ottawa, Canada.

Where occasional mastitis-infected animals are treated with penicillin this problem of inhibition of starter activity in the milk may not arise owing to dilution of the penicillin in the pooled milk supply. However, where extensive use of penicillin is being made, its inhibitory effect can be a source of considerable concern to the cheesemaker. Whitehead (*1*) suggests that milk obtained from cows during the 3-day penicillin treatment, and for one day thereafter, be used for purposes other than cheesemaking. The loss of this milk could be obviated most simply by addition of penicillinase.

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A Convenient and Rapid Method of Calibrating Warburg Manometers

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Although several methods have been described for the calibration of Warburg constant volume respirometers (*1, 2, 6*), it is generally agreed that calibration with mercury is the most reliable. Present descriptions (*1, 5, 7*) advise filling the inverted manometers through the neck from above, which is often cumbersome in practice due to the trapping of air bubbles in the column of mercury. We have recently used a variation of this method in which mercury is allowed to flow up into the manometer from below, thus avoiding this difficulty.

Using the method illustrated in Fig. 1, the time required for calibrating a manometer is reduced to less than 5 min. The only experimental value needed for calibration is the total volume (V) of the cup-manometer system, which for convenience is measured in two separate weighings. A scratch is placed on the neck of the manometer about halfway between the ground glass joint and the glass prongs that hold the fastening springs. The volume below this scratch will be referred to as V_C or the volume of the cup; while that above will be referred to as V_M, the volume of the manometer. The sum of V_C and V_M yields (V). Since the change in density of mercury between 20° and 28° is not significant in the determination of Warburg constants to two decimal places, these volumes are obtained simply by dividing the weight of mercury by 13.54.

Once (V) has been obtained, k_{O_2} and k_{CO_2} at 25° and at 37° may be read directly off the nomogram published by Dixon (*3, 4*) for the determination of Warburg manometer constants. For this, a hair line is stretched from the extreme left hand (V) scale across to the extreme right hand (v_F) scale, where v_F stands for the arbitrarily agreed on volume of fluid in the manometer cup.

For the convenience of workers unfamiliar with manometer calibration, the present method will be described in detail. All weighings are made on a crude pan balance to the nearest tenth of a gram.

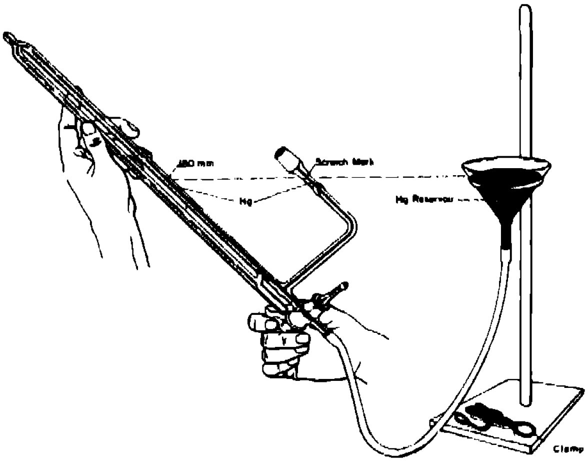

FIG. 1.

To obtain V_C:

1. Weigh the empty cup, stopper in place. Fill the cup completely with clean mercury, adjusting the level with a medicine dropper until the column of mercury just reaches the scratch mark when the cup is ground onto the manometer. Reweigh, and divide the net weight by 13.54 to obtain V_C.

To obtain V_M:

1. Attach a funnel to a ring stand as illustrated, and wire onto it a 3-ft piece of rubber tubing selected to fit snugly on the end of a manometer. Place a clamp on the end of the tubing and fill with about 100 ml of clean mercury.
2. Hold the inverted manometer above the level of the mercury reservoir and attach its lower end to the tubing. Remove the clamp and, slowly lowering the manometer, allow the mercury to flow evenly up into both the manometer limbs.
3. Leaving the mercury in free communication with the mercury in the reservoir, adjust the level of the mercury simultaneously in the two limbs until it just reaches the scratch mark on one side and the desired null point (180 mm for example) on the other. It is convenient to mark these two points with a thin red crayon for rapid identification.

The above adjustment is best done freehand with the elbows firmly planted on the table. The funnel should be adjusted to a convenient height depending on the operator. When the mercury columns are properly adjusted by combining the movements a) tipping the manometer, and b) raising and lowering it relative to the mercury in the funnel, the stopcock should be closed one-eighth (not one-fourth) of a turn with the marking dot down.

4. Raise the whole manometer, keeping it slightly tilted, and turn the stopcock another eighth of a turn thus allowing air to enter the end of the stopcock and the excess mercury to flow back towards the reservoir. Detach the tubing from the manometer after replacing the clamp.

5. Allow the mercury to flow into a tared vessel and divide the net weight by 13.54 to obtain V_M. Disregard the small amount of mercury in the channel of the stopcock as this is below the level of significance. A permanent record of the V_M values should be made for future reference.

The above maneuver requires perhaps 15 min of practice before repeatable results are obtained, but once mastered permits rapid calibrations in duplicate.

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Effect of Radioactive Phosphorus (P^{32}) in the Culture Medium on Growth and Viability of *Phomopsis citri* and *Diplodia natalensis*

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Some interesting results were obtained while studying the effects of radioactive phosphorus on the physiology of *Phomopsis citri* and *Diplodia natalensis*, the fungi commonly causing stem-end decay in oranges.

Potato dextrose agar was prepared in two lots that were identical in every respect, except that one lot contained 20 ml per l of a solution of radioactive phosphorus. The radioactivity of the solution introduced into the agar ranged from 0.156 to 0.245 μc/ml, with a half-life of 14.3 days. The control lot of agar was treated with an equal amount of 0.1% solution of NaH_2PO_4. Mycelial tufts of the fungi were transferred from pure cultures to the center of the agar in Petri plates, and the daily rate of growth of the cultures was determined by measuring increase in diameter. During four replications of the experiment the P^{32} showed a tendency to retard the growth of *Diplodia natalensis*, whereas the results with *Phomopsis citri* were not very consistent.

When transfers of the organisms were made from the Petri plates to orange fruits, the fungi that had been grown on radioactive media were slower in producing decay than were the control lots. California oranges were selected for inoculation to avoid the possibility of natural infection in the fruits, since the two fungi under consideration are rarely found in oranges produced under irrigation. A total of 400 fruits were employed, 200 of each variety. There were four lots of 50 fruits in each experiment. Inoculations were made by removing the stem-buttons, cutting a slit in the exposed stem with a sterile scalpel, and then forcing some of the agar and mycelia into the slit. Navel oranges were inoculated with mycelia from cultures in which the P^{32} had shown definite inhibitory effects on the rate of growth of the two fungi. In the experiments in which Valencia oranges were used, the inoculum was taken from cultures in which no significant retardation of either fungus had been produced by the P^{32}. Tests were made with navel oranges in April and with Valencia oranges in November, so that each variety was inoculated near the end of its commercial season, when one would not expect much resistance on the part of the fruits to pathogens.

TABLE 1

STEM-END DECAY IN CALIFORNIA ORANGES INOCULATED WITH FUNGI GROWN ON RADIOACTIVE AND CONTROL MEDIA

Variety	Days following inoculation	Percent showing decay					
		Phomopsis citri			*Diplodia natalensis*		
		Grown on radioactive media	Grown on control media	Chi square	Grown on radioactive media	Grown on control media	Chi square
Valencia	4	48	80	11.0	70	88	5.1
Washington navel	6	18	52	12.7	26	52	7.1

It will be noted in Table 1 that in all instances there was more decay in the oranges when inoculated with fungi from control media than when the inoculating organisms had been grown on radioactive media. The effect was not so pronounced with Valencia oranges as with the Washington navel variety. With the navels, the control fungi caused at least twice as much decay as did the fungi that had been cultured on radioactive media. However, the results in all instances were highly significant.

The ability of the fungi to cause decay was reduced by exposure to P^{32}, irrespective of whether or not growth of the organisms on culture media had been previously retarded. Furthermore, the radioactivity of the solutions employed was not great. The original solutions, with an activity of 0.156 to 0.245 μc/ml, were diluted 50 times in making up the culture media. At the time that the Petri plates were poured and inoculated, 1 ml of the agar emitted 10,000 to 11,000 counts per min. Inoculations were made into oranges a week or ten days later, and the amount of inoculum employed weighed approximately 20 mg. No radioactivity could be detected in the inoculum at the time that the oranges were inoculated. The delayed action of the fungi in infecting the fruits therefore appeared to be the result of previous exposure to P^{32} rather than to any actual radioactivity conveyed to the fruits in the inoculum. The very low activity of the original solutions suggests the possibility that greater dosages might be employed without too great an increase in health hazards.

It would be interesting to observe the effects of radioactive phosphorus on the subsequent decay of oranges, if the phosphorus were applied in the grove either as a spray or as a fertilizer. Although fungicidal sprays are employed in the groves, in commercial practice the most concerted efforts to control decay are made in the packing houses. However, control of stem-end decay of citrus fruits is made much more difficult because the two causal organisms become established in the stem tissues, and few fungicides will penetrate these tissues without injuring the fruits.

Progesterone in Blood Plasma of Cocks and Nonovulating Hens[1]

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Tests utilizing the method of Hooker and Forbes (*4*) have indicated the occurrence of progesterone in blood plasma of the regularly ovulating hens at least during certain phases of the ovulatory cycle (*3*). In extending these original observations, we thought it desirable to test raw plasma samples from males, and also from reproductively quiescent hens, as controls against possibly untoward reactions of the mouse endometrium to presumably progesterone-free plasma of avian origin. Preliminary tests unexpectedly yielded positive, and altogether typical, progesterone reactions. Additional assays confirmed these findings—the first direct evidence, so far as we are aware, of progesterone in the blood stream of normal males of any species.

The sex, breed, and age of the seven fowl furnishing plasma samples are recorded in Table 1, together with assay findings. Undiluted plasma (0.33 μg/ml) from the New Hampshire male did not give a positive reaction, possibly because of uterine distension or loss of material from the ligated segment. The questionable result from one of the females at the 1.0 μg/ml level may be accounted for similarly. All other findings are consistent among themselves; plasma from the two capons was completely negative at all levels tested.

The maximal levels of progesterone recorded in Table 1 are relatively high, ca. 3 μg/ml plasma, or about half the concentration most frequently encountered by Forbes and Hooker (*2*) and Hooker and Forbes (*5*) in mammals with active corpora lutea. The surmise that progesterone at these concentrations exercises some specific, if presently unknown, function seems reasonable.

TABLE 1

RESULTS OF ASSAYS FOR PROGESTERONE IN PLASMA FROM MALE, NONLAYING FEMALE, AND CASTRATED FOWL

Source of plasma			Progesterone, μg/ml*			
Sex	Breed†	Age	0.33	1.0	3.0	5.0
Male	W.L.	15 months	+	+	n.t.	n.t.
"	W.L.	16 "	+	+	+	–
"	N.H.	18 "	–	+	+	–
Female	W.L.	16 "	+	+	n.t.	n.t.
"	W.L.	16 "	+	±	+	±
Capon‡	N.H.	7 "	–	–	–	–
"	N.H.	ca. 4 years	–	–	–	–

* Plus and minus signs indicate presence and absence respectively of progesterone at indicated assay levels; n.t. no test at this level.

† Breeds: W.L., White Leghorn; N.H., New Hampshire.

‡ Castrated at 6 weeks of age. We are indebted to the Poultry Department, University of Maryland, for placing these capons at our disposal.

We cannot exclude the possibility that the substance in avian blood eliciting in the mammal the same reaction as progesterone may in fact not be progesterone. However, two of us (*6*) have recently completed tests of some 25 substances believed most likely to duplicate the action of progesterone; none of them did so in our tests. It is of especial relevance that testosterone and desoxycorticosterone acetate did not reproduce the effects of progesterone by the mouse assay (*4*).

Progesterone has been isolated from the adrenal glands of oxen (*1*), and pregnanediol concentrations in the urine of bulls are reported to exceed those normally found in the urine of pregnant cows, mares, or women (*7*). These and numerous other observations of an indirect nature have suggested that progesterone is not necessarily limited in occurrence to the female. The actual finding of progesterone in the blood stream of male fowl substantiates these views.

More extended investigations of avian and mammalian plasma from males, nonpregnant females, and castrates are currently in progress.

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[1] This investigation was aided by grants from the Committee for Research in Problems of Sex, National Research Council, and from the James Hudson Brown Memorial Fund of the Yale University School of Medicine.

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Comments and Communications

Concerning a Dog's Word Comprehension

It is difficult to be sure of the extent that animals are able to generalize the meaning of those words to which they do definitely react. Data in this connection are as apt to come from spontaneous occurrences as from outright experiment.

To us the word *table* means something with a top, any kind of top, with four legs most frequently, any kind of legs, that is any size, any shape, and is used for a variety of purposes. Can a dog know *table* in that sense? Is a table anything but a special object with which the dog has special associations?

A woman who owns a large male English setter named Topper had given him a bone periodically. This always had occurred in the kitchen. Accompanying the act she always had said "Table, Topper," whereupon Topper had promptly carried the bone under the kitchen table. The woman, of course, had merely wanted to keep the rest of her kitchen floor clean. The table is a good-sized kitchen table.

Now one day there was a party in the living room. There were candy wrappers. Topper saw them and went to work on them. The woman immediately said: "Table Topper." She meant that he should take the papers into the kitchen under the table and chew them there. Instead, the dog seemed confused a moment, looked around, then deliberately walked to a small decorative coffee table, squeezed himself under it with difficulty, head far out in front, rump far out behind, and there confidently chewed. Plainly *table* in that dog's mind stood for something general, with at least two quite different examples. I invited the woman and her dog to my laboratory. I gave him a bone. At the woman's command he instantly went under a laboratory table. We tested him with all kinds of tables. The dog always went under the nearest table, never under the nearest chair or into a corner or a niche. Some weeks later the woman called me. She and the dog had been out in the large field back of their house, and the dog had dug up a buried bone. Almost idly, the woman had said: "Table, Topper." She had thought there was no table but she was wrong. At the end of the field, definitely out of sight, was an old picnic table that had been left there the previous summer. Topper knew about that table, and there he patiently carried the bone and munched.

To me it appears that the "Table, Topper" has become a stimulus for an action that includes the understanding of *table* as a fairly extended concept. In the last situation the dog has even laboriously searched out a table that he remembers and that the woman has forgotten. That is, this dog seems to understand the word with something approaching the spread of implications that it has for us.

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Interference with the Ultramicro Ascorbic Acid Method of Lowry, Lopez and Bessey

The ultramicro method of Lowry, *et al.* (*J. biol. Chem.*, 1945, 160, 609) for the determination of ascorbic acid was used without special difficulty for nearly a year. Interference was subsequently encountered and since it may have been observed in other laboratories using this method, our experience with it and the means of avoiding it are herewith described. Interference was first encountered when an orange-red precipitate formed immediately after the addition of the dinitro-phenyl hydrazine reagent. This became progressively worse and occurred with blank, standard, and sample tubes alike. The precipitate dissolved only slightly upon addition of sulfuric acid and could not be completely removed by centrifugation. When it was possible to obtain a reading with the spectrophotometer on the reaction mixture, the values were high.

In an intensive effort to determine the cause of this precipitate, each of the reagents, including the distilled water, was systematically tested; the deep freeze storage unit was inspected for leaks of refrigerant; and other possible causative factors were sought. Finally, the cut-off ends of rubber sleeve stoppers, recommended by Lowry, *et al.* for sealing the micro tubes, were tested by extraction with 5% trichloroacetic acid, the protein precipitant used in the method. When this extract was added to the dinitro-phenyl hydrazine reagent, the characteristic precipitate formed immediately and consisted of the same needle-like crystals previously observed in the complete method.

A possible explanation for the failure of this interfering precipitate to develop when the method was first employed may be found in the fact that the rubber stoppers arrived with a protective coating. It was not entirely removed by the simple soap and water washing procedure. Perhaps the coating later wore off sufficiently to permit the liberation of some compound capable of reacting with the trichloroacetic acid and the dinitro-phenyl hydrazine reagent to produce the precipitate observed. Soaking the stoppers overnight in a 1N solution of sodium hydroxide in 80% alcohol, followed by thorough rinsing with distilled water, merely hastened the development of the precipitate.

The method is now successfully carried out by sealing each micro tube with a tiny oxygen-gas flame which closes it quickly without heating the tube contents or harming the ascorbic acid. Doubtless other satisfactory means of sealing these tubes can be found, but they should be tested first for possible interference with the reaction.

The chemical composition and properties of the precipitate are under investigation by one of us (R.R.S.)

at the Iowa State College Laboratories.

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Nevin S. Scrimshaw, and Leland C. Clark

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Aerating Liquids by Agitating on a Mechanical Shaker

Kluyver and Perquin's *Schüttelkulturmethode (Biochem. Z.*, 1933, 266, 68) has become a popular method of studying the physiology of molds. This method involves continuous agitation of submerged cultures on shaking machines and assures a more uniform supply of nutrients and oxygen to all cells as well as a more uniform removal of gaseous waste products than does the surface culture method. During studies on the metabolism of *Penicillium chrysogenum*, generously supported by the Bristol Laboratories, it became desirable to determine how much greater the potential supply of oxygen is in shaken media than in media kept stationary. Since certain media foam quite vigorously when shaken, the question of how seriously such foams interfere with the diffusion of oxygen also needed consideration.

Experiments to measure the rate at which oxygen diffuses into media would be most significant from a physiological point of view when performed with media that contain respiring cells. Unfortunately such experiments are also the most laborious to set up. For example, one could suspend varying amounts of cells in shake-flasks and observe the rate at which they take up oxygen. A graph of "volume of oxygen absorbed per unit time" plotted against "amount of cells" would indicate a direct proportion between the two until a further increase in cells no longer gave an increase in respiration. This would mean, provided that the supply of oxidizable substrate is adequate, that the rate of respiration has become so high that it is limited by the rate of oxygen diffusion into the medium. The rate of oxygen uptake corresponding to the horizontal portion of the curve would then be a measure of the rate at which oxygen diffuses into the medium. (Cf. Umbreit, Burris, and Stauffer. *Manometric techniques*. Minneapolis: Burgess, 1945, p. 9.)

One could, of course, determine the rate of diffusion more simply in the absence of respiring cells. These determinations unfortunately are subject to the criticism that any conclusions which they may suggest are not necessarily applicable to living systems. However, since at least preliminary information can be obtained in this manner, such determinations were made as follows: 150 ml of freshly boiled and rapidly cooled distilled water, sometimes containing added substances, were placed in 500-ml Erlenmeyer flasks, which were then plugged with cotton, and agitated at 28° C on a reciprocating shaker, having a 4-in stroke and shaking at a rate of 85 strokes per min. At zero time and at intervals thereafter, the amount of oxygen dissolved was determined by the Winkler method (American Public Health Association, *Standard methods for the examination of water and sewage*, New York, 1946). All determinations were made at least in duplicate.

Fig. 1 gives some typical absorption curves. Oxygen dissolved in agitated liquids very rapidly, nearly saturating the liquid within a few minutes. Diffusion into still water proceeded slowly, as expected. In all cases the rate of absorption was most rapid at the beginning of the experiment, and slowed down as saturation was being reached. Assuming the ideal case in which oxygen is used by the organisms as fast at it is furnished, one can estimate the potential oxygen supply from these high initial rates. For example, under our conditions oxygen diffused into shaken distilled water during the first 30 sec at a rate of about 30 ml of oxygen per hr per 150 ml of distilled water, which would theoretically support the growth of 1 g (dry weight) of cells having a Q_{O_2} of about 30. This estimate is made with reservations, since the presence of high concentrations of nutrients and of cells will reduce the solubility of oxygen.

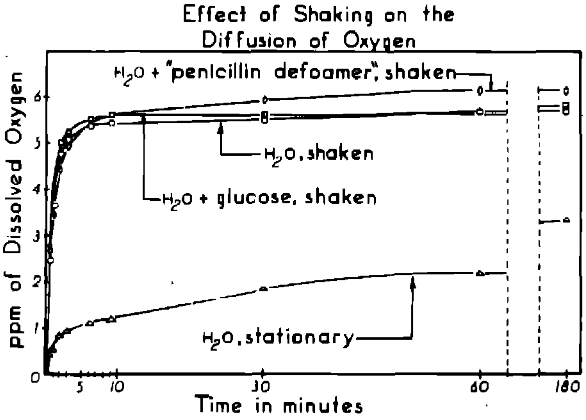

Fig. 1. The rate at which oxygen diffused during the first 30 sec, in ppm per hr per 150 ml of liquid was: 300 for shaken distilled water; 50 for stationary distilled water; 380 for shaken distilled water containing 0.05 ml penicillin defoamer; and 320 for distilled water containing 0.5% glucose.

Not only did oxygen diffuse six times more rapidly into agitated water than into quiet water, but the total amount of oxygen present after 3 hr was 70% greater in the shaken than in the undisturbed water. Furthermore, it also seems likely that until the still water becomes completely saturated with oxygen there is an uneven distribution of oxygen; however, no determinations were made to test the validity of this assumption. The addition of 0.05 ml of Swift's "penicillin defoamer," an antifoam agent used in the manufacture of penicillin, did not appear to have a significant effect on the diffusion of oxygen; neither did the addition of 0.5% glucose.

It was at first difficult to find an artificial system that might be comparable to a medium covered by a foam, because the various foams tested in preliminary experiments (such as beaten egg white, foams produced from solutions of corn steep liquor, Rinso, and Tide) either interfered with the Winkler method or were unstable. However, when nitrogen was bubbled from a Pyrex gas dispersion tube with fritted cylinder through a 2.5% solution of gum arabic, a thick foam developed which completely covered the solution and in spite of agitation stayed intact for about an hour. Fig. 2 shows that, as long as this foam persisted, the diffusion of oxygen was almost completely prevented. The possibility that the flushing with nitrogen removed enough oxygen from the overlying atmosphere to decrease the rate of diffusion was examined by repeating the experiment in the presence of 0.05 ml "penicillin defoamer." This antifoam agent prevented the foam, and diffusion proceeded at a fairly rapid rate. Flushing with nitrogen apparently did decrease the rate of diffusion somewhat, as can be seen from the absorption curve for the solution of gum arabic that contained the antifoam agent but through which no nitrogen was bubbled. The fact that oxygen diffused more slowly into the gum solution than into distilled water can probably be explained by an increase in the viscosity of the solution. Gum arabic did not interfere significantly with the Winkler titration. When gum concentration was increased in intervals of 0.5% from 0% to 3%, the diffusion rate decreased markedly while the titration blanks at zero time were about the same for all levels.

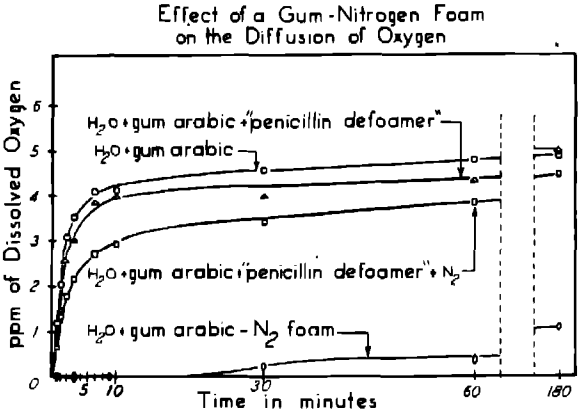

FIG. 2. The rate at which oxygen diffused during the first 30 sec, in ppm per hr per 150 ml of liquid was: 140 for the gum arabic solution; 150 for the gum arabic solution containing 0.05 ml of penicillin defoamer; 80 for the gum arabic solution that contained 0.05 ml of defoamer and through which nitrogen was bubbled; 0 for the gum arabic solution covered with a gum arabic-nitrogen foam.

These results do not necessarily imply that the foaming that occurs during actual shake-flask fermentations interferes as seriously with aeration as did the gum arabic-nitrogen foam in our experiments. They do, however, draw attention to the need for further studies on the aeration of microbial cultures.

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Only Qualified Praise of Chisholm's "Social Responsibility"

George Brock Chisholm's article (*Science*, January 14, p. 27) received the unqualified approval of Rollin G. Myers in your March 11th Comments and Communications section (p. 264), and it appears justified to express in these pages some criticism on a basic point of Dr. Chisholm's philosophy since it is hoped that almost everybody in this country, at least, will agree with Dr. Chisholm's aims and efforts in general.

The point in question is Dr. Chisholm's concept of "original sin." Dr. Chisholm says "The uncomfortable fact is that very few people indeed can love themselves in a healthy natural way which tolerantly accepts all their own human urges as normal and inevitable aspects of the healthily functioning man or woman. Most of us, by being civilized too early or too forcibly, have been driven to believe that our natural human urges are 'bad,' 'not nice,' 'wicked,' 'sinful,' or whatever the local equivalent may be. . . . Unfortunately, the concept of 'sin' is, under one name or another, very firmly entrenched throughout much of the world."

It would seem that Dr. Chisholm is unfamiliar with the history of the Christian concept of "original sin" and particularly with the attitudes of such outstanding contemporary theologians as Reinhold Niebuhr and Paul Tillich. Suffice it to quote from R. Niebuhr's *Beyond tragedy, essays on the Christian interpretation of history* in condensation as follows: "Sin is not so much a consequence of natural impulses which in animal life do not lead to sin as of the freedom of reason by which man is able to throw nature out of joint and to make fateful decisions in human history. . . . Sin lies at the juncture of spirit and nature. . . . The most basic need of the human spirit is the need for security. . . . The primary insecurity of human life arises from its finiteness and weakness. . . . When man looks at himself he finds himself to be only one of many creatures in creation. But when he looks at the world he finds his own mind the focusing center of the whole. When man acts he confuses these two visions of himself. He knows that he ought to act as to assume only his rightful place in the harmony of the whole. But his actual action is always informed by the ambition to make himself the centre of the whole. . . . When thought gives place to action, self intrudes itself into every ideal. . . . His sin is to turn creatureliness into infinity . . . when he centers his life about one particular impulse . . . tempted by his peculiar situation of being a finite and physical creature and yet gifted to survey eternity."

It is exactly, then, the recognition of being sinful, the concept of the ever-present danger of deceiving himself, which ennobles man and which offers a hope of overcoming the great difficulties of present international human relationships.

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Book Reviews

Physiology: vegetative physiology. (Part I.) (Fiat Review of German Science, 1939–1946.) Berlin, Germany: U. S. Army, Economics Division, Research Control Branch, APO 742, 1948. Pp. 224.

This review was organized by the Field Information Agencies Technical (FIAT) of the military government for Germany under the editorship of F. H. Rein. It covers, year by year, German literature on vegetative physiology and other literature on the subject with which the Germans were in contact for the years 1939 through 1946. The contents are "Further Developments of Physiological Methods," by H. Brünner, "Physiology of the Gaseous Components of the Blood," by E. Opitz, "Physiology of Blood Coagulation," by E. Wöhlisch, "The Peripheral Circulation," by M. Schneider, "Physiology of the Heart," by K. Kramer, and "Electrocardiography," by E. Schütz. All of the authors have covered their subjects well.

It is not easy to summarize a review which refers to half a dozen papers on nearly every page. The section on methods deals particularly with electrical methods, including electrical manometers and technics for gas analysis. Among these is an "oxygen sound," by which a lamp and photocell can be introduced into the heart in animals to measure oxygen content of mixed venous blood *in situ*. The second deals with arteriovenous oxygen differences in different organs; that of pure muscle blood is high during rest (30 to 70%) and very high in maximal work (over 90%). References are made to the German Himalayan expedition reports. The section on blood coagulation should be valuable to those working in this complex field. The fourth section gives attention to Rein's work on the subordination of chemical and nervous vasoconstrictor mechanisms to local effects during activity. The fifth section discusses the control of the intact heart as compared with the isolated heart, and Rein's theory of interrelations between liver and heart metabolism. "Electrocardiography" is not amenable to analysis.

The review refers to many other papers of importance which could not possibly be listed here.

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Biochemical evolution. Marcel Florkin. (Edited, translated and augmented by Sergius Morgulis.) New York: Academic Press, 1949. Pp. vi + 157. (Illustrated.) $4.00.

This short monograph fails to achieve the author's purpose as stated in his foreword. In the translator's preface it is suggested that "Some may object that the title is overambitious . . . and beyond the true measure of the book's scope." The reviewer does object and not only because, as suggested by the translator, "it deals with only half of the biological world." A major part of the book is devoted to a secondary purpose, i.e., to showing that a biochemical classification of animals does not differ from the taxonomy of morphologists. That a static classification of the animal kingdom, either biochemical or morphological, supports the common conception of evolution as a dynamic and continuing aspect of life is at least a debatable point. Approximately one-fourth of the text describes examples of so-called biochemical adaptations. The pitfalls encountered in considering adaptions as a factor in the evolutionary process are too well known to be emphasized. In the extreme analysis life itself could be cited as an adaption. The contribution of modern genetics to our understanding of evolution is barely mentioned.

The volume is well bound and the typography is excellent. The style of presentation is dull and uninspiring; perhaps it suffers in translation. Both biologists and biochemists will encounter a peculiar difficulty in reading the text: common, general taxonomic, and specific names are intermingled; thus, rat, oyster, and *Tenebrio molitor*. The important and extensive studies of the biochemistry of lower forms of animal life by Florkin and co-workers are discussed briefly in relation to the author's views on biochemical evolution. These studies could provide the material for a monograph apart from their relation to evolution. The reviewer suggests that this would have been of more interest as the present volume contains little about biochemical evolution that has not been expressed better by previous writers.

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Climatic accidents in landscape making: a sequel to "Landscape as developed by the processes of normal erosion." (2nd printing.) C. A. Cotton. New York: John Wiley, 1948. Pp. xx + 354. (Illustrated.) $7.00.

This is the second printing of a book issued in 1942. It is in part a sequel to the author's *Landscape*, which treats of land forms developed by common processes in humid climates. This volume deals with "interruptions" in "normal" geomorphic cycles.

Section I discusses dry and dry-seasonal climatic landscape types. It includes eolian erosion, arid erosion cycle, the cycle under semi-arid conditions, piedmont slopes and lateral planation, sheetflood erosion, the cycle of desert mountains, savana landscapes and inselbergs, and sand dunes. The reviewer does not consider these forms to be climatic accidents in a strict sense but rather results of specific climatic conditions, as "normal" as those resultant from humid climates.

Section II is a treatment of the salient features of glaciated landscapes. It treats of glaciers (in a brief and somewhat elementary fashion), glacial erosion (rather briefly), the manifold land forms resulting from glacier erosion (in considerable detail), the doctrine of glacial protection, and the constructional forms. In a long range geologic view these are climatic accidents, although scarcely more so than some other geomorphic phenomena which are not repeated with any great regularity. The discussion of erosional features produced by alpine glaciers is excellent and stimulating.

The illustrations, both text diagrams and photographs, are notable in their clarity and pertinence.

The author's effort has been successful in assembling and interpreting a vast amount of geomorphic data in two climatic environments, and in its synthesis into a coherent and interesting picture of land forms in arid and glacial climates. This is a book that should be on the reading shelf of all geomorphologists, geographers, and others interested in these climatic factors.

ARTHUR BEVAN

Illinois Geological Survey

Advances in protein chemistry. (Vol. IV.) M. L. Anson and John T. Edsall. (Eds.) New York: Academic Press, 1948. Pp. ix + 575. (Illustrated.) $8.50.

The eight reviews and essays in this volume deal with an interesting variety of themes bearing on the properties of proteins and amino acids.

In "Protein Gels," John D. Ferry surveys developments of the past few years, mainly on gelatin and fibrin gels, and provides a valuable discussion of the phenomenon of protein gelation. In "The Interactions of Proteins and Synthetic Detergents," Frank W. Putnam considers, in addition to the qualitative effects of surface active compounds on proteins and biological systems, evidence as to the mechanism of such interactions—binding via electrostatic forces, and the complex formation aided and stabilized by van der Waals' forces between nonpolar groups. "Proteins of Pathogenic Bacteria," by A. M. Pappenheimer, Jr., presents a brief but stimulating discussion of bacterial proteins (particularly from group A hemolytic streptococci), exotoxins and toxic enzymes, and methods for their extraction.

Alexander B. Gutman, in "The Plasma Proteins in Disease," furnishes a much needed review of a highly complicated subject. The critical discussion of methods, results, and their interpretations will be appreciated by the thoughtful reader. "Preparative Electrophoresis and Ionophoresis," by Harry Svensson, offers brief technical discussions of apparatus (compartment type and moving boundary) for the electrical fractionation of crystalloids and colloids. A. Neuberger, in "Stereochemistry of Amino Acids," gives well-organized discussions of the configuration of the amino acids, reactions involving substitutions on the α-carbon atom, catalytic racemization, and the occurrence of D-amino acids and their derivatives in nature. "X-Ray Studies of Amino Acids and Peptides," by Robert B. Corey, presents the results of diffraction studies on the atomic positions in crystals of diketopiperazine, glycine, DL-alanine and β-glycylglycine, and inferences therefrom as to the structures of and intermolecular forces in crystalline proteins. "Heme Proteins," by Jeffries Wyman, Jr., is an extensive survey "designed to bring out the beautiful interdependence of structure and function in the heme proteins, and in particular the balance between the character of the heme, the character of the protein, and the nature of the heme-protein linkage, in determining the properties of the molecule."

BARNETT COHEN

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Scientific Book Register

AMIS, EDWARD S. *Kinetics of chemical change in solution.* New York: Macmillan, 1949. Pp. ix + 332. (Illustrated.) $5.00.

ARNOW, L. EARLE. *Introduction to physiological and pathological chemistry.* (3rd ed.) St. Louis: C. V. Mosby, 1949. Pp. 595. (Illustrated.) $4.00.

BALDWIN, ERNEST. *An introduction to comparative biochemistry.* (3rd ed.) Cambridge, Engl.: Univ. Press; New York: Macmillan, 1948. Pp. xiii + 164. (Illustrated.) $1.75.

MCNEMAR, QUINN. *Psychological statistics.* New York: John Wiley; London: Chapman & Hall, 1949. Pp. vii + 364. (Illustrated.) $4.50.

MOORE, RAYMOND CECIL. *Introduction to historical geology.* New York-London: McGraw-Hill, 1949. Pp. ix + 582. (Illustrated.) $5.00.

SCHENK, EDWARD T., and MCMASTERS, JOHN H. (Revised by KEEN, A. MYRA, and MULLER, SIEMON WILLIAM.) *Procedure in taxonomy: including a reprint of the International Rules of Zoological Nomenclature with summaries of opinions rendered to the present date.* (Rev. ed.) Stanford, Calif.: Stanford Univ. Press, 1948. Pp. vii + 93. $2.50.

TESCH, J. J. *The thecosomatous pteropods: the Indo-Pacific.* (Part II.) (The Carlsberg Foundation's Oceanographic Expedition Round the World 1928–30 and Previous "Dana" Expeditions, No. 30.) Copenhagen: C. A. Reitzels; London: Oxford Univ. Press, 1948. Pp. 45. (Illustrated.) 10/.

The measurement of stress and strain in solids: based on the proceedings of a conference arranged by the Manchester and District Branch of the Institute of Physics on 11, 12, and 13 July 1946. London: Institute of Physics, 1948. Pp. x + 114. (Illustrated.) $4.00.

———. *Jaarboek der Koninklijke Nederlandsche Akademie van Wetenschappen.* Amsterdam: N. V. Noord-Hollandsche Uitgevers Matschappij, 1948. Pp. 225. (Illustrated.)

NEWS and Notes

James Stevens Simmons, dean of the Harvard School of Public Health, has been appointed chairman of the Advisory Medical Board of the Leonard Wood Memorial (American Leprosy Foundation). Gen. Simmons was recently awarded the Legion of Honor by the French government in recognition of his service to France as chief of the Preventive Medicine Service for the U. S. Army.

Alexander M. MacKay, Canadian anesthetic specialist, has been appointed subchairman of the Department of Anesthesiology at the University of Wisconsin to succeed **Ralph Waters**, who retired last fall.

S. C. Ogburn, Jr. has been made a director of the Foote Mineral Company of Philadelphia, where he holds the position of manager of research and development.

Francis W. Dunmore, co-inventor with the late Harry Diamond of the blind landing system for aircraft retired from the staff of the National Bureau of Standards after 31 years of service.

Ralph W. Sockman, chaplain of New York University and pastor of Christ Church, Methodist, has been made director of the Hall of Fame for Great Americans to succeed the late James Rowland Angell.

Abbott Research Laboratories has announced three recent appointments: **Marlin T. Leffler** as assistant director of research, **Marvin A. Spielman** as head of the organic research department, and **Arthur W. Weston** as assistant head.

Hans Lowenbach, associate professor of neuropsychiatry at Duke University, has been called to active duty by the U. S. Army Medical Corps for a year's service in the European theater.

Carl L. Titus, former director of the Magnetic Recorder Division, Armour Research Foundation, Chicago, has been appointed assistant director of the Stanford (California) Research Institute, where he will be in charge of development and industrial service.

Isadore Levin, director of the Physical Medicine Department, Doctors Hospital, Washington, D. C., has been appointed an associate professor of medicine, in charge of the Department of Physical Medicine of the Georgetown University School of Medicine.

Hans Brattström, of Lund University, Sweden, has been appointed professor of zoology at the University of Bergen, Norway. Professor Brattström is at present studying the fauna of the Pacific along the south coast of Chile.

Stanley A. Cain, plant geographer at the Cranbrook Institute of Science, will attend the ninth International Phytogeographic Excursion in Ireland in July. He will also attend a conference at Trinity College, Dublin, on current problems in glacial history of northeastern Europe.

Earle K. Plyler, of the National Bureau of Standards' Radiometry Laboratory, has been appointed consultant to the Atomic Energy Commission at Oak Ridge, where he will act as advisor on molecular spectra and infrared spectrometry.

John O. Brew, lecturer on anthropology and director of the Peabody Museum, has been appointed Peabody Professor of American Archaeology at Harvard University.

James A. Shannon, director of the Squibb Institute for Medical Research, New Brunswick, New Jersey, has been appointed associate director of the National Heart Institute in charge of research.

Arthur J. Eames, professor of botany, Cornell University, has been appointed president of the Section of Morphology and Anatomy of the Seventh International Botanical Congress to be held in Stockholm next year.

Visitors to U. S.

James F. Danielli, English cancer specialist and honorary secretary of the British Biological Council, gave a series of lectures at the University of Chicago, April 27–29.

Hideki Yukawa, nuclear physicist of Kyoto University, Japan, has been named visiting professor of physics at Columbia University for the 1949–50 academic year. Professor Yukawa is presently engaged in research at the Institute for Advanced Study at Princeton.

A. M. J. F. Michels, of Van der Waals Laboratory, Amsterdam, presented a paper on high pressure as a tool in the study of molecular physics at the recent meeting of the American Physical Society, in Washington, D. C.

L. H. Gray, of the Radiotherapeutic Research Unit of the Medical Research Council, Hammersmith Hospital, London, spoke on the influence of morphology of the ionization tract on the biological effects of radiation, at the Argonne National Laboratory seminar held April 22. **Lars Melander**, of the Sweden Nobel Institute, Stockholm, was another recent visitor at Argonne.

Grants and Awards

Gilbert Grosvenor will be the first recipient of the National Geographic Society's newly established Grosvenor Medal. He will be given the medal May 19, on his 50th anniversary as editor-in-chief of the National Geographic magazine.

The U. S. Atomic Energy Commission will finance 21 new research programs in biology and medicine, under contract with 16 universities and two hospitals. Eleven of the contracts will be administered directly by the AEC; the remainder by the Office of Naval Research. The contracting institutions, administrative offices, project supervisors, and studies to be made are as follows:

Amherst College, ONR, *H. H. Plough*, research in radiobiology and chemical genetics; University of Cincinnati, ONR, *Robert Kehoe*, studies on chronic berylliosis, tumor production by beryllium, and analytical methods; Columbia University, AEC, *S. C. Werner*, use of radioactive iodine in developing quantitative assay method for thyrotropic hormone; University of Delaware, ONR, *Mary A. Russell*, comparison of the effects of X-rays, neutrons, and mustard compounds on the growth and development of corn seedlings; University of Denver, ONR, *Fred E. D'Amour*, the physiologic and pathologic effects of radioactive cobalt; Duke University, ONR, *Philip Handler*, metabolic studies with radioactive isotopes; University of Florida, AEC, *A. A. Bless*, bioelectric potentials of plants and animals as a function of radiation injury; Henry Ford Hospital, Detroit, AEC, *F. W. Hartman*, survival of red blood cells after treatment with nitrogen mustard; Johns Hopkins University, AEC, *Abel Wolman*, proposed investigation of adsorption and assimilation of radioactive waste by bacterial slimes; University of Kansas, AEC, *E. R. Hall*, radium chloride and hemopoietic physiology of native rodents; Meharry Medical College, ONR, *Paul Hahn*, treatment of neoplasms; University of Michigan, ONR, *Fred J. Hodges*, radioautography; Mount Sinai Hospital, New York City, AEC, *R. Loevinger*, measurement of tissue dose due to gamma and beta active radioisotopes; University of North Carolina, AEC, *C. P. Van Cleave* and *C. T. Kaylor*, radioautographic study of beryllium 7; North Carolina State College (three contracts): (1) ONR, *J. A. Weybrew*, metabolism of copper; (2) AEC, *W. C. Gregory*, peanut seed irradiation; (3) AEC, *N. S. Hall*, movement of ions through soils systems; Purdue University, ONR, *Heinrich Koffler* and *P. A. Tetrault*, use of radioactive isotopes in studying mold metabolism, with emphasis on the assimilatory mechanisms of *Penicillium chrysogenum*; Washington University School of Medicine, ONR, *Wendell Scott*, experiments to determine the feasibility of developing equipment that will be capable of mapping the outlines of organs or deposits of metastatic tumor within the body; Yale University (two contracts): (1) AEC, *E. C. Pollard*, monomolecular layers of serological agents; (2) AEC, *E. C. Pollard*, irradiation of viruses and large molecules.

Vannevar Bush, president of the Carnegie Institution and wartime chairman of the Office of Scientific Research and Development, has been awarded the 1949 medal of the Industrial Research Institute for his coordination of industrial and academic research with the defense effort.

Fellowships

Massachusetts Institute of Technology's department of aeronautical engineering announces the following five graduate fellowships for 1949–50: **Richard C. du Pont Memorial Fellowships** in aeronautical engineering, for graduate students in any year of work toward an advanced degree, tuition plus $1200 single, $1800 married (two available). **Douglas Aircraft Company Fellowship**, for a graduate student, $1500 (one available). **Goodyear Tire and Rubber Company Fellowships** for graduate students, $1500 (two available). Further details may be obtained by writing Professor J. C. Hunsaker, Department of Aeronautical Engineering, Massachusetts Institute of Technology, Cambridge 39, Massachusetts.

The National Research Council announces the availability of 50 Atomic Energy Commission Technical Fellowships in Radiological Physics. These fellowships, which are administered by the NRC, are intended to develop a pool of trained individuals to meet the many needs of industrial laboratories, AEC plants, and hospitals. The primary requisites in the selection of the technical fellows is an undergraduate degree with a major in physics, chemistry, or engineering (usually electrical or chemical) with a minor in mathematics, biophysics, or similar fields; applicants with other qualifications may be considered in special cases. Applicants must be citizens of the U. S. under 35 years of age.

Fellows will probably be assigned for training to one of the AEC installations. The training programs may differ in detail among the training organizations, but will cover the general subjects of radiation measurements, industrial hygiene and toxicology, sanitary engineering, radiation biology, introduction to research, modern physics, nuclear physics, and mathematics. The annual basic stipend is $1,500 for a single fellow, and up to $2,500 for a married fellow. Tuition, fees, and travel expenses will be paid. Initial appointments will be for one year, and reappointment may be made upon application if warranted by the progress of the fellow. Applications will be acted upon in June, and only those applications completely documented by *June 10* will be considered by the NRC Fellowship Board at that time. The fellowships will begin at the start of the academic year 1949–50. Requests for application blanks or additional information should be addressed to the Fellowship Office, National Research Council, 2101 Constitution Avenue, Washington 25, D. C.

Colleges and Universities

Harvard University's School of Public Health has announced a new training program for cancer control officers, financed in part by grants from the U. S. Public Health Service and the Massachusetts Division of the American Cancer Society. The course is open to candidates for the degrees of Master of Public Health and Doctor of Public Health and provides training for doctors, statisticians, and health educators for participation in cancer control work. The program will be directed by Leonid S. Snegireff, associate professor of cancer control at the Harvard School of Public Health.

Summer Programs

San Francisco State College will hold a field school of natural history June 27–August 6 in Bixby Canyon, Monterey County, California. The course will offer first-hand field experience for students of college level, with emphasis on the identification of plants and animals and their interrelationship with nonliving surroundings. Further information may be had by writing the Division of Natural Science, San Francisco State College, 124 Buchanan Street, San Francisco 2.

A new 6-month course in nuclear science will be given at **Reed College**, Portland, Oregon, under the sponsorship of the Atomic Energy Commission. It is designed to meet the needs of post-doctoral fellows under the AEC's Division of Biology and Medicine, but is open to other qualified persons. The summer session will be held July 5–September 10 and will include a review of physics and introduction to nuclear physics by Kenneth Davis, assistant professor of physics; a review of mathematical analysis and introduction to statistics by Robert A. Rosenbaum, associate professor of mathematics; and a review of the principles of chemistry by Arthur F. Scott, professor of chemistry, and Josef F. Bunnett and Arthur H. Livermore, assistant professors of chemistry. Information on the program may be obtained by writing the AEC Training Program, Reed College, Portland 2, Oregon.

A special summer course, Catalysis in Organic Chemistry, will be offered at the Ipatieff Cataysis Laboratory at **Northwestern University** by Herman Pines, of the Universal Oil Products Company. Inquiries should be addressed to R. K. Summerbell, Chairman, Department of Chemistry, Northwestern University, Evanston, Illinois.

The New England Association of Chemistry Teachers will hold its 11th summer conference August 22–27 at the University of New Hampshire, at Durham. Further information may be had by writing the conference secretary, Carl P. Swinnerton, Pomfret School, Pomfret, Connecticut.

The Second Annual Industrial Mycology Short Course will be held at **Purdue University** July 11–23. The course will include a series of evening lectures, a morning lecture-laboratory course in mold isolation and identification, and an afternoon course in physiology of the fungi. Further information may be obtained by writing to M. M. McClure, Division of Technical Extension, Purdue University, Lafayette, Indiana.

Industrial Laboratories

Vitamin B_{12}, the heretofore rare pernicious anemia specific, will now be available in large quantities, **E. R. Squibb and Sons** has announced. Members of the Squibb research staff have discovered that B_{12} can be obtained from streptomycin mold.

Calco Chemical Division, American Cyanamid Company, Bound Brook, New Jersey, has consolidated its research, process development, and dyes technical service into a new department, to be known as Research and Development Department. It will be headed by K. H. Klipstein. H. Z. Lecher has been named director of research in charge of chemical research.

Meetings and Elections

The Company Member Conference of the American Standards Associaton will meet May 19–20. The first day's session will be held at the Benjamin Franklin Hotel, Philadelphia and will be devoted to discussions on standardization, by which it is the aim of the conference to improve service to industry and the consumer. Frank P. Tisch, chief engineer of the Pheoll Manufacturing Company and vice chairman of the Sectional Committee on Screw Threads, will discuss the importance to American industry of the British-Canadian-U. S. agreement on unified screw threads (see *Science*, April 1, 346). A tour of the Princeton Laboratories of the Radio Corporation of America, where a number of recent electronic developments are now on trial, is planned for May 20. Colleges and industrial organizations in the Philadelphia area are invited to send representatives to the meeting.

The Inter-University High Altitude Laboratory will hold a cosmic ray symposium at Echo Lake, Colorado, June 22–28. The U. S. Atomic Energy Commission and the Office of Naval Research will be co-sponsors with the six cooperating universities —the University of Chicago, Cornell University, University of Denver, Massachusetts Institute of Technology, New York University, and Princeton University. Discussion meetings on radiation will be led by Marcel Schein, those on properties of mesons by Carl D. Anderson, on nuclear interactions of cosmic rays by Bruno Rossi, and on showers by Hans Bethe and Kenneth Greisen. About 60 participants have been invited, and scientists who are not issued invitations may attend. Further details may be obtained from Byron E. Cohn, Department of Physics, University of Denver, Denver 10, Colorado.

The International Union of Chemistry will hold its 15th conference in Amsterdam September 6–10. Official U. S. delegates will be Roger Adams, University of Illinois; Ralph Connor, Rohm and Haas Company; Warren C. Johnson, University of Chicago; H. F. Mark, Polytechnic Institute of Brooklyn; Emil Ott, Hercules Powder Company; and Edward Wichers, National Bureau of Standards. W. Albert Noyes, Jr., chairman of the NRC Division of Chemistry and Chemical Technology, and vice president of the IUC, will also attend.

The National Academy of Sciences, at its annual meeting in Washington April 25–27, elected as vice president for a four-year term beginning July 1 Edwin Bidwell Wilson, professor emeritus of vital statistics, Harvard School of Public Health. (The other Academy officers are: president, Alfred N. Richards; foreign secretary, Detlev W. Bronk; home secretary, Fred E. Wright; treasurer, William J. Robbins.) Chosen as council members for a three-year term ending June 30, 1952, were: Joel H. Hildebrand, professor of chemistry, University of California at Berkeley; and Ernest W. Goodpasture, professor of pathology and dean of the School of Medicine, Vanderbilt University. (Other council members are: Alfred N. Richards, Edwin B. Wilson, Detlev W. Bronk, Fred E. Wright, William J. Robbins, Carl R. Moore,

W. Albert Noyes, Jr., J. Robert Oppenheimer, and Donald D. Van Slyke.)

Newly elected Academy members are: George W. Bartelmez, professor of anatomy, University of Chicago; Frank A. Beach, professor of psychology, Yale University; Robert B. Brode, professor of physics, University of California at Berkeley; Paul R. Burkholder, Eaton Professor of Botany, Yale University; Lowell T. Coggeshall, professor and chairman, Department of Medicine, and dean, Division of Biological Sciences, University of Chicago; Max Delbrück, professor of biophysics, California Institute of Technology; Robert C. Elderfield, professor of chemistry, Coumbia University; William F. Gibbs, vice president, Gibbs and Cox, New York City; William W. Hansen, professor of physics, Stanford University; Charles B. Huggins, professor of surgery, University of Chicago; Walter D. Lambert, U. S. Coast and Geodetic Survey (retired); Howard B. Lewis, professor and head of Department of Physiological chemistry, University of Michigan; Francis W. Loomis, professor and head of Department of Physics, University of Illinois; Thomas S. Lovering, U. S. Geological Survey; Samuel M. McElvain, professor of chemistry, University of Wisconsin; Saunders MacLane, professor of mathematics, University of Chicago; Nicholas U. Mayall, Lick Observatory; Otto Meyerhoff, research professor of physiological chemistry, University of Pennsylvania; John S. Nicholas, Sterling professor of biology, Yale University; George B. Pegram, professor of physics and dean of graduate faculties, Columbia University; Kenneth S. Pitzer, professor of chemistry, University of California at Berkeley; Kenneth B. Raper, senior microbiologist, Northern Regional Research Laboratory, U. S. Department of Agriculture; John L. Savage, chief designer, U. S. Bureau of Reclamation, Denver; Carl F. Schmidt, professor of pharmacology, University of Pennsylvania; Julian Schwinger, professor of physics, Harvard University; Harry L. Shapiro, professor of anthropology, Columbia University; Oliver R. Wulf, professor, Division of Chemistry and Chemical Engineering, California Institute of Technology; Ralph W. G. Wyckoff, scientist director, National Institutes of Health; Frederick W. H. Zachariasen, professor and chairman of the Department of Physics, University of Chicago.

Six new foreign associates were elected by the Academy: Elie Cartan, professor of geometry, University of Paris; Paul A. M. Dirac, Lucasian professor of mathematical physics, St. John's College, Cambridge, England; Bernard Lyot, astronomer, Meudon Observatory, Seine-et-Oise, France; Henri Piéron, director, Laboratory of Physiological Psychology, The Sorbonne, Paris; Arne Tiselius, professor of biochemistry, University of Upsala, Upsala, Sweden; Öjvind Winge, director, Department of Physiology, Carlsberg Laboratory, Copenhagen (Valby).

The first branch of RESA, the Scientific Research Society of America, was installed at the Esso Research Club of the Standard Oil Company (New Jersey) in Linden, New Jersey, April 20. More than 300 research men, visiting scientists, and officials of the company were present. The afternoon program included an inspection trip of the laboratories of the new Esso Research Center, recently dedicated, and of the Bayway Refinery. The installation address on "Fuels and the Internal Combustion Engines of the Future" was given by Charles F. Kettering, of General Motors Corporation.

NRC News

The National Research Council has announced the awarding of the RCA Predoctoral Fellowships in Electronics to eight graduate students. The awards are supported by the Radio Corporation of America, and the selection of fellows was made by the RCA Fellowship Board of the National Research Council.

The newly appointed fellows and their fields of research are: *Charles K. Birdsall*, Stanford University, interaction of electric fields and electron streams; *David Carter*, Stanford University, electron bunching by means of electromagnetic waves; *William A. Craven, Jr.*, Princeton University, microwave techniques including generation, amplification, and transmission; *Gerald Estrin*, University of Wisconsin, microwave propagation and field theory; *Fumio Bob Naka*, Harvard University, focal properties of cathode-ray guns and illuminators; and *Howard C. Poulter*, Stanford University, interaction of electromagnetic waves and electron streams and its use in new types of vacuum tubes. Fellows whose awards have been renewed for another year are: *Arthur L. Aden*, Harvard University, for work in electromagnetic engineering and allied fields, with possible applications to meteorology; and *Robert W. Olthuis*, University of Michigan, for work in low pressure gas discharge applications at microwave frequencies.

The NRC has also announced ten awards of the Merck Postdoctoral Fellowships in the Natural Sciences. These fellowships are supported by Merck and Company, Inc., and the selection of fellows was made by the Merck Fellowship Board of the National Research Council.

The new appointees and their research topics are: *Melvin Cohn*, Pasteur Institute, Paris, biochemistry, immunochemistry, and enzymology, especially adaptive enzymes of bacteria; *Ruth Sager*, Rockefeller Institute for Medical Research, genetics: gene actions, gene and cytoplasm relations, cytoplasmic inheritance; *Robert C. C. St. George, Jr.*, California Institute of Technology, biological chemistry: cellular physiology with some emphasis on the chemistry of vision; *Edward C. Taylor, Jr.*, Laboratorium fur Organische Chemie, Zurich, stereochemistry of the pentacyclic triterpenes of the β-amyrin type. Fellows whose grants have been renewed, and their fields of work, are: *David H. Brown*, Washington University Medical School, synthesis and properties of compounds of biological interest; *Malcolm Gordon*, California Institute of Technology, intermediary metabolism; *Caspar W. Hiatt, 3rd*, Rockefeller Institute for Medical Research, chemical factors of natural immunity and the physical chemistry of proteins; *R. W.*

Lumry, Jr., University of Utah Medical School, enzyme kinetics as related to protein structure; *Clement L. Markert*, California Institute of Technology, embryology; and *Gunther S. Stent*, California Institute of Technology, physical chemistry, structure of high polymers, biophysics, bacterial viruses.

Deaths

W. Halsey Barker, 42, assistant dean of the Johns Hopkins University School of Medicine, died March 26 at Johns Hopkins Hospital, where he had been a patient for two months.

Jonas Borak, 56, Viennese radiologist who came to New York City ten years ago as a refugee, died April 4 of a heart ailment while lecturing at the New York Academy of Medicine.

Alphonse A. Thibaudeau, 64, head pathologist at the New York State Institute for the Study of Malignant Diseases, and former instructor in bacteriology at the University of Buffalo, died at his home in Buffalo April 6 following a brief illness.

Irving Hotchkiss Pardee, 57, neurologist at the Neurological Institute, Presbyterian Hospital, and at St. Luke's Hospital, New York City, and professor of neurology at Columbia University, died April 10 after a brief illness.

Whitman Cross, 94, geologist and authority on rose culture, died April 20 at Rockville, Maryland, after an illness of five years. Dr. Cross had been head of the U. S. Geological Survey for 37 years when he retired in 1925.

Catherine V. Beers, 57, associate professor of zoology at the University of Southern California, died April 22. Dr. Beers had done considerable work in genetics.

Sir Robert Robertson, 80, British chemist and director of the Salters Institute of Industrial Chemistry since 1937, died April 28 in London, after a brief illness. Sir Robert directed explosives research at Woolwich Arsenal during both world wars.

William H. Bauer and Irwin Gordon, Rutgers University ceramists, recently announced the **successful synthesis of single crystals of mullite**, a silicate rarely found in nature but occurring in the firing of certain ceramic materials. A new approach to silicate technology is suggested with the possibility of synthesizing commercially important silicates such as tourmaline, used in sonic detectors and electrical frequency controls.

The Federation of American Scientists, at its annual council meeting in Washington April 30–May 1, issued the following statement on National Science Foundation legislation:

"During the recently concluded hearings on National Science Foundation legislation before the House Committee on Interstate and Foreign Commerce, strong opposition to the entire Foundation concept was voiced by the National Patent Council. It appears that this organization has succeeded in arousing unfounded fears among small manufacturers and business men that the Foundation 'would inevitably dry up the creative fountainheads of American industry by stifling individual incentive to invent and produce.' In recent weeks Congressmen have had a steady flow of mail urging this point of view. The majority of the committee now considering the legislation is not likely to be impressed, since they have given sufficient study to the bills to recognize the falsity of the charges. But other Congressmen, who will make the final decision on the House floor, may be impressed if their mail continues to be predominantly opposed to the bill.

"The great majority of scientists, whatever the disagreements on detail, favor the establishment of a National Science Foundation. The long course of the legislation can be finally and successfully ended in the next month. It must not be jeopardized by silence on the part of scientists, silence which will be interpreted as indifference. The Federation of American Scientists calls upon all scientists and their organizations, recognizing that this is the critical hour for establishment of a National Science Foundation, to communicate directly with their own representatives in Congress urging them to vote for the National Science Foundation Act of 1949 when it reaches the floor of the House."

The newly elected officers of the federation are: Hugh C. Wolfe, associate professor of physics at the College of the City of New York and president of the federation's New York chapter in 1947–48, chairman; Clifford Grobstein, biologist at the National Cancer Institute, vice chairman; and Gerhart Friedlander, chemist at Brookhaven National Laboratory, secretary-treasurer.

The ornithological life of the Arctic area 200 miles south of the north magnetic pole will be studied this summer by the government-sponsored Perry River Expedition, which is to leave Edmonton, Alberta on May 17. The team of three scientists includes an Englishman—Peter Markhan Scott, waterfowl painter and director of the Seven Wild Fowl Trust—and two representatives of the U. S. Fish and Wildlife Service—Paul Queneau, research ornithologist of Westport, Connecticut and Harold C. Hanson, of the Illinois Natural History Survey. They will observe the flora and fauna of the region and make an intensive study of five fowl, the American brant, the black brant, the Ross goose, the tule goose, and the white-fronted goose. The team will be joined by Eskimo guides at Victoria Island in the Arctic and will mush 150 miles with dog sleds across the ice. James Bell, Canadian bush pilot, will join the expedition in July, when the thaw permits him to land his small plane.

An association for mutual information on blood groups has been proposed by P. H. Andresen, chief of the Serological Department, University Institute of Legal Medicine, Copenhagen, Denmark, with the aim of making new developments in this field more readily available to individual research workers. All researchers engaged in blood group work are invited to join. Inquiries may be sent to Dr. P. H. Andresen, Frederik V's Vej 9, Copenhagen, Denmark. Members will receive *Blood Group News*, a monthly bibliography on blood group work. A limited number of copies will be on sale by Ejnar Munksgaard, Copenhagen.

F. Firbas, Botanische Anstalten der Universität, Göttingen, Germany, has reported that the systematic-plant geography library of the University was completely destroyed during the war. He would be very grateful for any reprints in those fields that *Science* readers might send him.

The Association of American Medical Colleges recently announced the opening of its **Medical Film Institute**, with offices in the Academy of Medicine Building, 2 East 103rd Street, New York City. The MFI will function as an advisory body, providing producers and sponsors of medical films with an authoritative opinion as to the scientific, educational, and cinematic qualities of a proposed film. The Department of State has commissioned the MFI to select a group of the newest and best medical films for presentation abroad as part of the U. S. Information Service film program.

The Advisory Committee, headed by Walter A. Bloedorn, dean of George Washington University's School of Medicine, includes Francis Keppel, dean of Harvard's Graduate School of Education; Robert V. Schultz, chief of the Audio-Visual Training Section of the Navy Bureau of Medicine and Surgery; Orville Goldner, former head of Navy Training Films; and William A. Benedict, chairman of the American Medical Association's Committee on Medical Motion Pictures.

A new periodical, ***Physiologia Plantarium*****,** covering all branches of plant physiology, is being published quarterly, as the official publication of the Scandinavian Society for Plant Physiology. The papers are printed in either English, French, or German. Nonmembers of the society may place subscription orders with Einar Munksgaard, Norregade 6, Copenhagen, Denmark or through local booksellers, but only members may submit contributions.

The National Registry of Rare Chemicals, 35 West 33rd Street, Chicago 16, Illinois, lists the following wanted chemicals: indican, 5-keto-D-gluconic acid, tri-(p-isocyanatophenyl)methane, hemocyanin, 2,2'-dihydroxyazobenzene-3-sulfonic acid, 3,6,2',4'-tetrahydroxyflavone, 1-hydroxyphenazine, 1-hydroxyacridine, 1-hydroxy-2-anthramine, pyrographitic oxide, phthionic acid, 8-nitro-1-naphthoic acid, coriamyrtin, n-(β-diethylaminoethyl)phenothiazine, L-lyxose, 9-methyl-2,6,7-trihydroxy-3-fluorone, phenylpantothenone, monodeuteroethylene, hexafluorobutadiene, and 2-hydroxy-1-anthramine.

Make Plans for—

Society for Applied Spectroscopy, symposium, Brooklyn Polytechnic Institute, May 21, Brooklyn.

Canadian Psychological Association, May 26–28, Mount Royal Hotel, Montreal.

American Medical Association, annual session, June 6–10, Atlantic City, New Jersey.

Symposium on Fine Particles and Resolutions, June 9–10, Stevens Hotel, Chicago.

American Society of Electroencephalography, June 11–12, Chalfonte-Haddon Hall Hotel, Atlantic City, New Jersey.

International Conference on Science Abstracting, June 20–25, Unesco House, Paris, France.

1st International Congress of Biochemistry, August 19–25, Cambridge, England.

4th International Conference of the International Association of Quaternary Research, August 22–September 15, Budapest, Hungary.

Recently Received—

News from Unesco. A fortnightly publication from the Bureau of Public Information, Unesco, 19 Avenue Kléber, Paris 16, France.

The behavior of rocks and rock masses in relation to military geology, by Wilmot R. McCutchen. (Quarterly of the Colorado School of Mines, Vol. 44, No. 1). Single copies obtainable from the Colorado School of Mines, Golden, Colorado, at $1.00 each.

Technical & Scientific Cooperation: Projects Coordinated by the Interdepartmental Committee on Scientific and Cultural Cooperation in 1948. Issued in February 1949 by the Office of Public Affairs, Department of State, Washington, D. C.

Sugar and Sugar By-Products in the Plastics Industry by Louis Long. Technological Report Series No. 5. Available at no charge from the Sugar Research Foundation, Inc., 52 Wall Street, New York 5, N. Y.

Papers on the Soviet Genetics Controversy. Occasional Pamphlet No. 9 of the Society for Freedom in Science. Copies obtainable from the Assistant Secretary, Society for Freedom in Science, Dept. of Zoology, University Museum, Oxford, England at 1/3.

Story of Vitamin B_{12} by Ruth Woods. In *Borden's Review of Nutrition Research*, Vol. X, No. 1. The Borden Company, 350 Madison Avenue, New York 17, N. Y.

Immigrant Plants in the Hawaiian Islands, II, by F. Raymond Fosberg. Occasional Paper 46, University of Hawaii, Honolulu, Hawaii.

Importance of Upwelling Water to Vertebrate Paleontology and Oil Geology by Margaretha Brongersma-Sanders. Tweede Sectie, Deel XLV, No. 4. Koninklijke Akademie van Wetenschappen, Amsterdam (C.), Holland.

Fifth Semiannual Report of the Atomic Energy Commission, January 1949. U. S. Government Printing Office, Washington, D. C.

Abridged Scientific Publications from the Kodak Research Laboratories, Vol. XXIX, 1947. Eastman Kodak Company, Rochester, New York.

National Health Council, Annual Report, March 25, 1949. Prepared by National Health Council, 1790 Broadway, New York 19, N. Y.

Service, a monthly publication of Cities Service Company, 703 Ring Building, Washington 6, D. C.

Science Graduate Students and Their Support

M. H. Trytten, *Director*

Office of Scientific Personnel, National Research Council

FELLOWSHIP PROGRAMS IN THE SCIENCES have burgeoned in the past ten or fifteen years, and particularly since the recent war, because educational and industrial groups recognize the ever-increasing need for competently trained scientists. New fellowship programs are also being proposed under federal auspices, as in the current Science Foundation legislation. What the extent of such programs should be, in order to meet the need for additional support, is uncertain, because fellowship offerings could conceivably be too plentiful. New programs should not offer so many opportunities as to lead to lowered standards in American educational institutions. Furthermore, too many additional appointments might upset the traditional pattern of using graduate students as instructors for undergraduate courses. While some change in this pattern might be desirable, a major shift would create serious administrative problems in the universities. Many hold that fellowship offerings should be adequate to assist all interested students who have demonstrated genuine ability. What this order of magnitude might be, however, has not been determined heretofore, for lack of enough information on the number of graduate students and their means of support.

To throw light on the need for fellowship support, the Office of Scientific Personnel of the National Research Council undertook in the late spring of 1948 to collect information from colleges and universities on their enrollments in the sciences for the academic year 1947–48. Questionnaires were distributed directly from the Office of Scientific Personnel to colleges not granting advanced degrees, soliciting information on those students graduating with a science major in 1948, and on junior science majors. For information from institutions granting advanced degrees, questionnaires were distributed through the professional societies in the various fields, with two exceptions. Chemistry was omitted because the American Chemical Society had recently distributed a questionnaire on enrollments and engineering because the percentage of engineering graduates going on to advanced work is smaller than in other fields so that the OSP questionnaire would not have been suitable.

Response was sufficient to indicate that reasonably reliable over-all estimates could be drawn from the information obtained. The four-year colleges responding were generally those that have furnished most of the students going on to advanced study, as judged by the number who have taken advanced degrees in science. On this basis, the responding colleges represent about 80 percent of the graduating scientists in institutions which have produced successful graduate students in the past.

The number of universities responding varied for different sciences; in each field the return was from the head of the department to the cooperating professional society. By comparing the number of doctorates granted by these institutions with the total number of degrees granted in each field for the corresponding year, it was possible to judge the percent of the population covered and so arrive at good estimates of national totals.

An independent check on the data is the U. S. Office of Education survey of graduates with science majors for the school year 1947–48. The totals for the number of graduating science majors estimated by the two independent surveys agree within 8 percent. The Office of Scientific Personnel survey is admittedly less representative of the very small colleges which have graduated few science majors in the past, because the response was less satisfactory from such schools. This accounts, in part, for the fact that the Office of Scientific Personnel total is about 8 percent less than that of the U. S. Office of Education. Since only an order of magnitude was desired, however, the agreement seems satisfactory; also, the distribution of science majors by fields has been determined.

The distribution of B.S. science majors given by the U. S. Office of Education is as follows:

Agriculture and agronomy	5,112	Geology	1,007
Anatomy	111	Mathematics	4,106
Bacteriology	556	Pharmacy	1,075
Biology	6,306	Physics	1,923
Botany	387	Physiology	131
Biochemistry	473	Psychology	5,916
Chemistry	7,183	Forestry	810
Entomology	95	Zoology	2,036

The Office of Education total of B.S. graduates with science majors in 1948 is 38,107. The OSP total is 35,099 after applying a factor to adjust for nonresponding schools. Therefore, the figure of 36,000 will be used, since the Office of Education figure includes many institutions where science majors may represent low concentrations in the field.

The questionnaire of the OSP differed from that of the Office of Education in that it asked for information on plans of the students and certain judgments concerning competence. The heads of departments were asked to state the number of their students who were deemed qualified to go on to advanced degrees. The estimate was uniformly more flattering for the four-year colleges than for the universities, for while university department heads estimate that only about 17 percent of their graduating majors are clearly doctoral degree timber, the heads of departments in the colleges estimate that about 25 percent are so qualified. One can assume this means either that the four-year colleges have more competent students or that their faculties are perhaps less critical in their judgment. For the purposes of this study, the smaller percentage (17 percent) has been used. This percentage of the number of graduating science majors (using a figure between the Office of Education figure and the OSP figure) amounts to approximately 6,100 seniors who are deemed good doctoral candidates in the judgments of their teachers. Slightly more than one-third this number, however, did not intend to go on for graduate work in the sciences because of other interests and opportunities, so that there were left about 3,800 science majors who desired to go on to graduate work in the sciences and were apparently very able. It is interesting to compare this figure with the number of science doctorates granted in the United States in 1948—approximately 1,750.

About 20 percent of all graduates in the sciences were planning to begin advanced work soon after graduation. Those who graduated from universities seemed to have an advantage over those who graduated from four-year colleges; 10 percent of the science majors from universities were expecting support of a scholarship or fellowship not requiring services, whereas less than 1 percent from the four-year college expected to receive such scholarship aid. Almost half of those from universities who were planning to start graduate work were receiving support requiring services, while only 38 percent from the colleges were receiving such support.

Of those judged competent to go on for a doctoral degree, about 25 percent would not be able to for lack of financial support, the percentage being approximately the same for graduates of the different types of institutions. Since, as we have noted, there were about 3,800 1948 science graduates who had the desire and the ability to go into advanced work, it appears that about 1,000 fellowships for the first year of graduate work would be necessary to insure these able students an opportunity to study. It should be remembered that the class of 1948 was larger than prewar classes and may not be typical.

In the returns on graduate enrollments, the major group omitted is chemistry. Some idea of the totals in that field, however, can be obtained by noting that chemistry majors were about 21 percent of all science majors at the B.S. level in 1948. Chemistry doctorates were about 32 percent of all science doctorates in 1946, 27 percent in 1947, and 28 percent in 1948. It is probable, therefore, that chemistry graduate students constitute roughly one-fourth of the graduate population in the sciences.

Table 1 shows that about 80 percent of all graduate students are carrying one-half or more of a full-time training schedule. These are probably all resident students on the campus; Table 2 indicates the type of support they receive. The remaining 20 per-

TABLE 1

DISTRIBUTION BY FIELDS, TYPES OF APPOINTMENTS, AND TYPES OF TRAINING SCHEDULES

Sciences	Total number of students	Average hours per week worked by nonresearch appointees	Percent carrying more than half full-training schedule	Percent carrying half full-training schedule
Agriculture and agronomy	1,014	19	50.7	24.1
Anatomy	82	14	41.5	12.2
Botany (including ½ biology)	687	15	58.4	28.2
Entomology	139	14	55.4	44.5
Forestry	55	14	87.2	3.6
Genetics	99	15	57.6	31.8
Geology	1,029	15	65.5	18.0
Horticulture	223	16	42.6	29.6
Mathematics	2,845	10	48.7	19.6
Pharmacology	94	16	54.8	37.2
Physics	3,214	14	54.2	23.9
Physiology	170	12	66.0	19.4
Psychology	3,256	14	66.5	18.7
Zoology (including ½ biology)	784	11	67.1	22.8
All sciences	13,691	13.4	57.9	21.8

cent are probably off-campus students, employed full-time elsewhere.

The total percentage of persons receiving support, exclusive of veteran benefits, according to this table, is 66.4. There may be some overlapping in the various categories because some students are receiving simultaneously two or more types of support, such as fellowships and teaching assistantships. Analysis of the numbers in the different categories indicates that such overlap is probably not great. It will be noted, however, that nearly half of all graduate students are receiving G. I. benefits, which obviously overlap other types of support in a great percentage of cases.

Table 3 shows the number of graduate students in American universities in the various sciences aside from chemistry and engineering. As pointed out before, about 21 percent of the graduating science majors at the baccalaureate level in 1948 were chemists, and about 28 percent at the doctoral level in 1947 and 1948. It seems safe, therefore, to adjust the total of 18,000 shown in the table by adding one-third, making a total of 24,000 science graduate students aside from engineering. This may be compared with the total of 36,000 science majors graduating from college in 1948, 20 percent of whom indicated they intended to enter graduate school. It will be noted that the faculties estimate that 8,451, or 47 percent of the graduate enrollment (exclusive of chemistry), are likely to complete the doctorate. According to this estimate, the number of doctorates in five years adjusted to include chemists rises to approximately 11,400 or 2,280 per year. Some graduate students enrolling later than 1948 may also achieve a doctorate in this period and would add to the figure. However, 47 percent of all graduate students achieving a doctorate seems an unduly high estimate and the average given seems unlikely to be exceeded. The annual rate of granting doctorates in American universities approximately doubled each decade up to the peak year of 1941, and if this rate of increase had continued there would have been 4,000 doctorates granted in 1951. It appears that this rate of training is far in the future.

A recent report is of interest in this connection. In the January 1949 issue of *The Educational Record*, published by the American Council on Education, there is an article by C. Gilbert Wrenn, reporting on studies made at the University of Minnesota under the auspices of the Associated Research Councils and

TABLE 2

TYPE OF SUPPORT RECEIVED*

Sciences	Research appointments				Nonresearch appointments	Major fellowships		Minor fellowships		Veteran benefits
	% Reporting	% of Total enrollment	% of Column B on government contracts	% of Column B on industrial contracts	% of Total enrollment	% of Total enrollment giving no service	% of Total enrollment giving service	% of Total enrollment giving no service	% of Total enrollment giving service	% of Total enrollment receiving benefits
Agriculture and agronomy	72	31.4	4.0	11.6	10.1	12.0	8.1	3.8	0.8	51.7
Anatomy	43	28.1	43.4	No rep.	22.0	28.1	10.9	No rep.	12.1	32.9
Botany (including ½ biology)	82	20.6	9.9	10.6	35.9	10.9	9.7	2.9	14.4	30.2
Entomology	27	21.6	23.3	33.3	24.4	5.7	2.1	0.7	20.1	50.3
Forestry	14	16.3	No rep.	83.3	36.4	8.6	9.0	7.2	0.0	83.6
Genetics	44	86.4	No rep.	No rep.	14.2	4.0	19.1	1.0	6.0	46.4
Geology	85	6.4	4.5	12.1	32.6	7.7	10.0	5.9	12.9	67.7
Horticulture	64	29.6	No rep.	7.5	13.9	2.6	17.9	3.1	7.1	85.4
Mathematics	98	2.5	61.0	No rep.	28.6	4.0	9.6	1.9	11.5	31.8
Pharmacology	35	61.7	81.0	12.0	9.6	25.5	18.1	6.5	14.8	86.1
Physics	70	17.6	93.6	1.9	82.2	5.0	9.7	3.0	10.5	40.6
Physiology	28	31.7	81.4	11.1	16.4	8.2	18.8	7.6	24.1	45.8
Psychology	86	6.2	48.0	7.0	14.6	4.1	5.6	2.4	5.0	43.9
Zoology (including ½ biology)	52	11.8	30.1	7.2	35.1	4.0	10.5	4.8	15.8	34.8
All sciences	72.8	13.0	47.7	7.6	24.0	6.1	9.8	3.0	10.1	43.5
	A	B	C	D	E	F	G	H	I	J

* All figures adjusted to 100% response. All averages are weighted averages.

based on information partly supplied by the Office of Scientific Personnel. It indicates a median score on an I.Q. scale of 141 for a large sample of persons who achieved a doctorate in the sciences. It also indicates that, at this level of ability, about one-third of the population does not finish college. This suggests that the number of highly qualified persons who might go on to advanced training if they had the necessary incentive and opportunity may be as high as 50 percent of those now completing college.

The questionnaire asked how many additional students could be accepted for graduate training. From the replies, it appears that substantial numbers of students can yet be accommodated in all fields. About twice as many can be accepted for classroom training as for work requiring facilities for laboratory research. However, only half as many additional candidates for the doctorate in theoretical research can be accepted as in experimental research. This latter situation varies greatly from field to field.

TABLE 3

DISTRIBUTION AMONG THE VARIOUS SCIENCES AT DIFFERENT LEVELS OF TRAINING*

Sciences	% Reporting	Adjusted totals enrolled	% First year enrollment	% Second year enrollment	% Accepted for or working on doctoral dissertations	Number considered likely to achieve doctorate in 5 years
Agriculture and agronomy	72	1,408	40.0	30.8	28.9	769
Anatomy	43	190	47.9	38.9	47.9	116
Botany (including ½ biology)	82	777	38.5	37.7	47.6	507
Entomology	27	515	42.3	51.1	33.8	344
Forestry	14	393	52.7	43.5	18.0	164
Genetics	44	225	39.5	30.5	34.2	115
Geology	85	1,211	45.0	40.9	25.8	515
Horticulture	64	348	57.5	36.8	22.4	169
Mathematics	98	2,303	48.4	29.5	12.2	690
Pharmacology	35	209	48.7	34.0	38.2	206
Physics	70	4,591	42.3	32.9	24.6	2,226
Physiology	28	600	50.0	35.2	32.7	317
Psychology	86	3,786	56.5	26.9	24.2	1,664
Zoology (including ½ biology)	52	1,411	47.3	34.2	29.8	640
All sciences	72.3	18,117	47.9	32.9	25.6	8,451

* Figures reported are as of April 1, 1948, but are adjusted to represent 100% reporting.

An interesting piece of information brought out by the questionnaire is the clear indication of interest in postdoctorate fellows. Respondents reported that they could and would like to entertain almost ten times as many postdoctorate fellows as they now have.

In summary then, it may be said that information furnished by colleges and universities indicates a total of approximately 6,000 graduates at the bachelor's level in 1948 who are judged competent to achieve a doctorate in the sciences. Of these, about 4,000 are interested in going on to graduate work and about 1,000 of these do not have financial support.

Appreciation is expressed to Dr. F. M. Weida, who prepared the statistical material in this report.

Chemical Induction of Colonial Paramorphs in *Neurospora* and *Syncephalastrum*[1]

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GENETIC ALTERATION in fungi has been found to give rise to two main classes of mutant strains. Most thoroughly investigated have been the "biochemical" types of mutants, in which specific defective biosyntheses have been demonstrated (*3, 4*). The other class includes the "morphological" mutant types, which differ from the wild type in growth habit, and which in general cannot be restored to normal by varying the physical or chemical environment of the mutant strain. Distinctive colonial types of morphological mutants have been described as "button" (*11*), "colonial" (*1*), or "cauliflower" (*8, 13*), and several have been shown to differ from the wild type by single genes (*1, 11*).

It has been found that on the addition of certain chemicals to culture media the morphology of wild-type cultures of *Neurospora* will change so that they closely resemble in growth habit certain genetically determined colonial types. These phenomena are obviously important because of their possible relation to the mechanism of gene-determined morphogenesis in fungi, and also because of their practical utility in handling these microorganisms. The term *paramorph* is proposed to designate a fungus culture in which morphological changes have been environmentally induced without any corresponding genetic alterations. It is thought that paramorph (paramorphic phenocopy) or *paramorphic culture* more exactly expresses the desired meaning than the term *phenocopy* as used by Goldschmidt (*7*). Phenocopy has been applied to environmental duplication of specific gene effects on development. Paramorph refers to a *class* of morphological changes in a less differentiated organism. Since *paramorphogenic* activity would involve an environmentally induced qualitative change in growth habit, it is to be distinguished from toxicity effects in which a colony may grow to a limited extent before it is killed by a chemical. In the experiments here described, the colonial paramorphic cultures transplanted to inhibitor-free medium have always grown, and have resumed their normal growth habit.

Littmann (*12*) observed that the addition of 1.5 percent dehydrated ox gall to culture media restricted mycelial growth of certain fungi. Since desoxycholic acid is a normal constituent of ox bile, we have tested the effects of the addition of sodium desoxycholate to culture media, and have found that it restricts the growth of *Neurospora* and the mucoraceous fungus *Syncephalastrum racemosum* to a compact thallus or colony. Further tests have shown that a number of other agents added to either liquid or solid media are likewise capable of producing colonial paramorphs in these fungi. Typical results obtained with some of these substances are given in Table 1. The most suitable concentration of sodium desoxycholate for the production of small discrete colonies of either fungus is 0.03 to 0.035 percent (9×10^{-4} molar) in medium buffered to pH 7.0.

Since sodium desoxycholate is surface-active, another anionic surface-active agent, Tergitol 7[2] (sodium 3,9-diethyltridecanol-6 sulfate) was tested and found to induce similar growth changes in both organisms. The most suitable concentration was 0.00175 percent (5×10^{-5} molar) when added to autoclaved medium.

The observation that inositol-requiring mutant strains of *Neurospora* grown in suboptimal concentrations of inositol form pellets in liquid culture (*2*), and form restricted colonies on agar media, suggested the possible relation of inositol to the paramorphic effects described above. Since gammexane (γ-hexachlorocyclohexane) has been shown to be a specific inhibitor of certain biological and enzymatic activities of inositol (*5, 9, 10*), the colonial paramorphogenic activity of gammexane was investigated. As shown in Table 1, this compound, added to either minimal or complete agar media in a concentration of 0.025 percent, was found to be a moderately effective paramorphogenic agent for *Syncephalastrum*. Its effect on wild-type *Neurospora* is much less marked, giving only a slight modification of morphology and no appreciable change in growth rate. These effects of gammexane cannot be reversed by inositol.

L-Sorbose, the keto-hexose listed in Table 1, is also paramorphogenic, but differs from the other compounds in that much higher concentrations are required for activity. In addition, colonies on sorbose-containing agar media remain restricted in growth for

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[1] Work done in part under a grant-in-aid from the American Cancer Society upon recommendation of the Committee on Growth of the National Research Council.

[2] Sample obtained by courtesy of Carbide and Carbon Chemical Corporation.

periods up to 15 days, while with the other compounds the cultures tend to form aerial mycelia earlier. The paramorphogenic effect of sorbose can be reversed, apparently competitively, by other sugars; glucose, sucrose (see Fig. 1), and more slowly by maltose and by mannose. Other compounds tested, including glycerol, fructose, lactose, starch, and galactose, are much less active in reversing the sorbose effect, although they are used by *Neurospora* as carbon sources.

The paramorphogenic activity of sorbose for both *Neurospora* and *Syncephalastrum* is evidence against a direct relation of surface activity to colonial paramorphogenic activity in all cases. This view is also supported by the additional findings that paramorphogenic activity of surface-active agents is limited to certain anionic compounds. Each of the compounds listed below has a surface tension activity between 25 and 40 dynes per cm for a one-percent solution (*6*); yet their paramorphogenic activities vary both quantitatively and qualitatively. Of the anionic agents, sodium lauryl sulfate and aerosol OT (dioctyl sodium sulfosuccinate) produced colonial paramorphs at concentrations comparable to effective concentrations of Tergitol 7 and sodium desoxycholate, whereas sodium oleate was inactive. The cationic surface-active agents tested, Roccal (alkyl-dimethyl-benzyl-ammonium chloride) and Isothan 15 (lauryl isoquinolinium bromide), were very toxic, but showed no paramorphogenic activity. Tween 80 (polyoxyethylene derivative of sorbitan monooleate), the only nonionic surface active agent tested, was not toxic at concentrations up to

TABLE 1

EFFECTS OF PARAMORPHOGENS ON *Neurospora* AND *Syncephalastrum* CULTURES

Compound	Concentration	Medium			96-hr growth on solid medium*	
		Type	pH	Carbon source	*Neurospora*†	*Syncephalastrum*‡
	%			%		
Sodium desoxycholate	.01	min.	7.0	1.0 S	spreading	
	.02	min.	7.0	1.0 S	SR	R—5 mm
	.03	min.	7.0	1.0 S	R	
	.03	compl.	7.0	1.0 S	R—30 mm	
	.03	compl.	7.0	0.1 S		R—5 mm
Tergitol 7	.001	min.	5.5	1.0 S	R—10.0 mm	
	.0015	min.	5.5	1.0 S	R— 2.5 mm	
	.002	min.	5.5	1.0 S	R— 1.0 mm	
	.002	min.	5.5	0.1 S	R	R—2 mm
	.002	compl.	5.5	0.1 S	SR	spreading
	.004	MDA	4.7	4.0 D		R—4 mm
	.04	MDA	4.7	4.0 D		R—1 mm
Gammexane	.025	min.	5.5	0.1 S	SR	R—1 mm
	.025	compl.	5.5	0.1 S	SR	R—4 mm
	.05	min.	5.5	0.1 S	SR	
	.05	MDA	4.7	4.0 D		R—2 mm
L-Sorbose	1.0	min.	5.5	0.1 S	R	R—2 mm
	1.0	compl.	5.5	0.1 S	R	R—2 mm

* Characterization of growth, or average colony diameter in mm.

† Normal growth rate: 4.0 mm per hr. Similar results obtained with 5 lines tested; *N. crassa* SY4a, Abbott 12A, Chilton a, *N. tetrasperma*, and *N. sitophila* 299-pyridoxinless (pyridoxin added to minimal medium).

‡ Normal growth rate: 0.7 mm per hr. Average of 4 strains; 479 New Britain S. W. P., 527 Quebec, Canada, 551 Columbia University Culture Collection, and 742 Panama Canal Zone.

R—restricted growth
SR—slightly restricted growth
S—sucrose
D—Dextrose

MDA—minimal dextrose asparagine agar
min.—Neurospora minimal agar
compl.—Neurospora minimal agar supplemented with vitamins, enzyme-hydrolyzed casein, and yeast extract

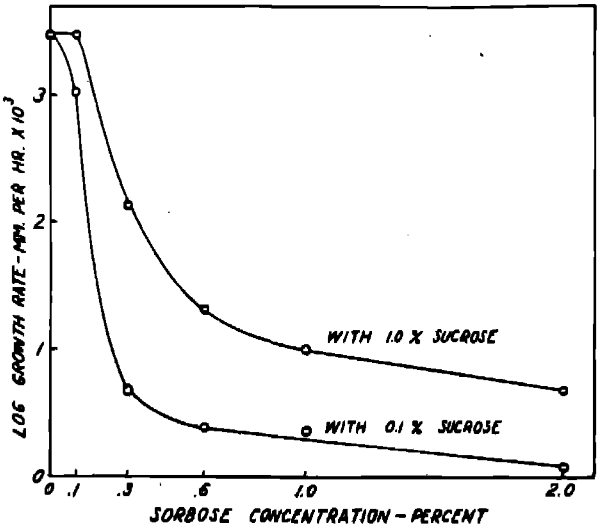

FIG. 1. Effect of sucrose on the paramorphogenic activity of sorbose on *N. crassa*. Linear growth rates determined at 25° C in growth tubes. Note differences in growth rate on two levels of sucrose.

one percent, and was inactive as a paramorphogen. There is no evidence that inositol is directly involved in the paramorphogenic activities of the other chemicals, since high concentrations of inositol have no effect on paramorphogenesis by sodium desoxycholate, Tergitol, or sorbose with *Neurospora*, or on that by desoxycholate with *Syncephalastrum*. Furthermore, bio-assays of *Neurospora* mycelium grown in the presence of Tergitol 7, or of sorbose, showed no significant variations from the normal inositol content. In addition, sorbose has no significant effect on the requirement of the *inositolless* mutant for inositol. These findings suggest that the paramorphogenic agents tested do not influence either inositol utilization or inositol synthesis by *Neurospora* or *Syncephalastrum*.

In addition to theoretical considerations, the use of paramorphogens provides a new and valuable tool for handling many colonies on microbiological plating media. Sorbose has been selected as the standard colonial paramorphogen, because colonies on sorbose show no tendency to form extensive aerial mycelia, and because, in comparison with the other compounds, the effective concentration range of sorbose is wide, and survival is significantly better. Media containing 0.8 percent sorbose and 0.1 percent sucrose or 0.2 percent sorbose and 1.0 percent glycerol have been used effectively. The value of the sorbose technique in mutation studies has been demonstrated, using a strain of *Neurospora* which has a wild-type growth rate and which produces exclusively uninucleate microconidia (*1*). Microconidia were treated with X-rays (20,000 r) and plated directly into complete medium containing sorbose. Nineteen hundred colonies arising from the treated microconidia were isolated and examined for mutants; 24.2 percent morphological variants and 3.1 percent biochemical mutants were recovered, with considerably less labor than is required by other techniques. In 500 control isolates 0.2 percent morphological and no biochemical mutants were recovered.

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Purine Metabolism in *Tetrahymena* and Its Relation to Malignant Cells in Mice[1]

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ONE OF THE PRIME GOALS of studies involving metabolic inhibitors has been the discovery of useful chemotherapeutic agents which could be directed against invading organisms of man. Accordingly, if tests on bacteria *in vitro* seemed promising the compound was subjected to tests on the same microorganisms and others *in vivo*. When metabolic inhibitors which blocked reactions peculiar to the invader but not to the host were discovered (e.g. sulfonamides for *p*-aminobenzoic acid), then useful treatment resulted. Following these initial findings (*6, 18*), a long list of compounds have been tailored to inhibit many natural metabolites, and great strides have been made toward an understanding of competitive inhibition of specific enzymes by antimetabolites (*19*).

While certain encouraging reports have appeared in the literature concerning the retardation of the growth of neoplastic tissue following the injection of folic acid antagonists (*5, 15, 17*), nitrogen mustards

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(*1, 3, 17*), and recently 2,6-diaminopurine (*4*), the differential between neoplastic inhibition and host toxicity is exceedingly narrow or nonexistent. This narrowness of differential effect is what is to be expected when inhibitors of metabolites essential to the host are employed. Our knowledge of the biochemical pattern of cancer cells, and indeed of animal cells in general, has been too incomplete to formulate a rational attack on cancer with any assurance that the inhibition would be specific for the cancer. In other words, no single, clear-cut qualitative biochemical difference between normal and malignant cells was known.

Our work on the animal microorganism *Tetrahymena geleii* has demonstrated its biochemical similarity to the vertebrates in regard to amino acid (*10*) and vitamin requirements (*13*). There are, however, a few striking differences between the protozoan and the vertebrate, such as the total lack of sucrose-splitting enzymes, and presence of guanine and uracil requirements in *Tetrahymena*. The purine and pyrimidine metabolism has been subjected to intensive investigation, since it was felt that these very differences from the mammalian metabolic pattern might prove to be useful tools. It has been pointed out that, while the mammal can synthesize guanine from adenine (*2*), it cannot make use of dietary guanine for the reverse reaction. *Tetrahymena*, on the other hand, cannot synthesize guanine but requires this purine in its diet (*11*). A similar situation exists in the case of uracil, which, while required by the protozoan (*11*), fails to be metabolized by the mammal when it is added to the diet (*16*).

During a comprehensive study by Hitchings and co-workers (*8, 9*) of substances designed to interfere with nucleic acid synthesis, compounds were produced which provided tools for attacking these problems. These authors have pointed out that such substances might be expected to have chemotherapeutic effects even on the basis of the difference in rate of nucleic acid synthesis between host and parasite (*8*).

Studies on substituted pyrimidine (*12*) have shown that competitive inhibition results when certain substitutions are made and inhibition indices from < 20 to > 1000 were found.

Inhibition indices (based on complete inhibition) from 0.075 to 300 were found when a number of substituted purines were tested (*14*). Evidence was presented which seems to indicate that the most powerful purine inhibitor encountered (5-amino-7-hydroxy-1H-v-triazolo [d]pyrimidine) produces its effect by being incorporated in the nucleoprotein, and this incorporations depends upon its structure, which is that of a guanine analogue. Thus the guanine analogue, which we will call guanazolo, has an inhibition index (calculated for half-maximum growth) of 0.02, the 2,6-diaminopurine analogue (5,7-diamino-1H-v-triazolo[d]-pyrimidine) which we will call diaminazolo, has an index of 27, while the hypoxanthine analogue (7-hydroxy-1H-v-triazolo-[d]pyrimidine) is inert.

The suggestion was made (*16*) that if invasive organisms could be found with a purine metabolism similar to that of *Tetrahymena*, then guanazolo should inhibit their development without being metabolized by the host. Tests on mice showed that the compound was nontoxic when repeated doses were given over a three-day period.

With this background we were ready to determine whether or not cancer cells were similar to normal cells in this phase of their purine metabolism. Accordingly we chose a rapidly growing transplanted mouse adenocarcinoma[2] (Eo771) for our initial test and both guanazolo[3] and diaminazolo for the possible inhibitors, on the theory that if the cancer cell had lost its ability to synthesize guanine (or gained the ability to metabolize guanine), then guanazolo should cause growth retardation while diaminazolo should be relatively ineffective in moderate concentrations. This theory appears to be correct, and the number of mice in this series of experiments has now reached over 300.

Fig. 1 illustrates the striking difference in tumor size between the control group and the guanazolo-treated group. The number of mice in this initial experiment was small (eighteen divided into three equal groups), and the standard deviations of the control group and those which received the diaminazolo overlapped to an extent which indicates little or no significant difference between the two. Accordingly no

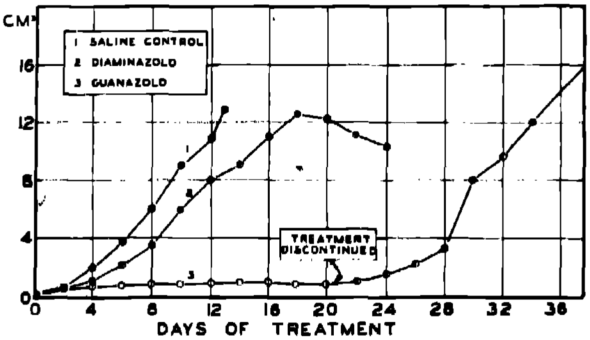

FIG. 1. Adenocarcinoma Eo771. Eighteen inoculated mice (C57 black) were used in this experiment (6 in each series). Dosage 500 γ twice daily, subcutaneous. Size of tumors (cm³) averaged in each series. Treatment started 6 days after inoculation.

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[2] Purchased from the Roscoe B. Jackson Memorial Laboratory.

[3] All but one sample of the guanazolo used was obtained through the cooperation of Dr. Hitchings. The remaining sample was sent to us by Dr. R. O. Roblin, Jr. of American Cyanamid Company.

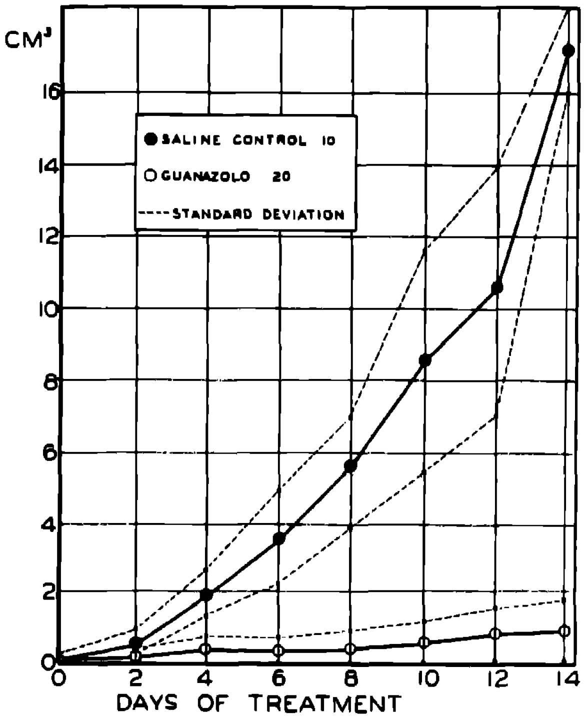

FIG. 2. Adenocarcinoma Eo771. Thirty inoculated mice (C57 black) were used in this experiment (10 control; 10 given 500 γ of guanazolo twice daily subcutaneously; 10 given 500 γ of guanazolo twice daily intraperitoneally). Since there was no detectable difference in the route of administration the tumor sizes of all the guanazolo-treated mice were averaged.

further tests were run using diaminazolo. Almost complete cessation of tumor growth resulted during guanazolo treatment (the tumors were six days old when treatment was instituted), but growth resumed shortly after the treatment was discontinued.

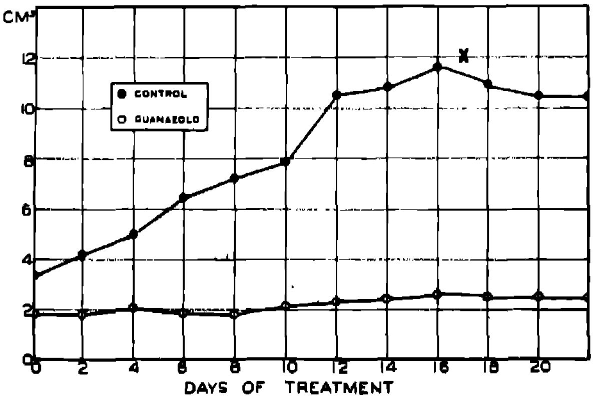

FIG. 3. Spontaneous mammary cancer in C3H mice. Twelve mice were used in this experiment (6 control; 6 given 1 mg of guanazolo twice daily intraperitoneally). The initial segregation into the two series was random, and the inclusion of the largest tumor in the control group (dead at 15 days, marked X on curve) raised the average of the tumor size of the control series over the treated series at the start of the experiment.

Subsequent experiments employing substantial numbers of tumor-bearing mice have completely duplicated the results of the first experiment on this type of malignancy. Graphic representation of one such series of 30 mice is shown in Fig. 2. The treatment in this case was divided equally (10 each) between saline control, 0.5 mg of guanazolo twice daily administered subcutaneously, and the same amount of guanazolo given intraperitoneally. No difference in the effect on the tumors was found between the two routes of guanazolo treatments.

TABLE 1

LYMPHOID LEUKEMIA

Effects	Length of treatment (days)	Ten mice treated*	Ten control mice (untreated)
White blood cells (ave.)	5	9,600	11,080
" " " "	12	5,011	20,175
Percent lymphoblasts (ave.)	10	0.8	32
" " "	13	1.0	21
No. palpable tumor masses	13	1	10

* With 500 γ guanazolo twice daily, starting 3 days after inoculation. The particular preparation of guanazolo (17–3) used in this experiment produced a leukopenia after prolonged treatment. That a contaminating substance in this preparation produced the effect was shown by observations on normal mice treated with 17–3 and normal mice treated with another preparation (17–4). No leukopenia developed after four weeks of treatment with 17–4 (1 mg twice daily), whereas leukopenia did develop with 17–3. There was, however, complete retardation of adenocarcinoma Eo771 and spontaneous mammary cancer in C3H mice following the administration of 17–4.

Pathological findings[4] show that this level of treatment does not cause the death of the malignant cells, but only checks their growth.

Due to the extreme activity of guanazolo as an antiguanine, it has been difficult to reverse its activity. Massive doses of guanylic acid, calculated on the basis of *Tetrahymena* activity ratios, administered together with effective levels of guanazolo, have given indications of inhibitor release, but the guanylic acid is so insoluble that the effective blood levels are much below those required for complete release. The data at hand, however, are consistent with the theory that the effect of guanazolo on the cells of Eo771 is the same as in *Tetrahymena*.

With the evidence of a real biochemical difference between the cancer cells of Eo771 and the normal mammalian cells, and the mechanism of the reaction between the inhibitor and enzyme system indicated, it was of the utmost importance to test the general occurrence of this difference in other types of malignancy. We have had the time and opportunity to investigate only two other cancers. One was the spontaneous mammary cancer of strain C3H[5] mice, the results of which are shown in Fig. 3. The other was a lymphoid leukemia (lymphoma 2) in strain A mice,[6] the results of which are shown in Table 1.

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[4] Control and treated mice were sent to Dr. Joseph C. Aub, director of the Cancer Commission of Harvard University and the pathological studies were made by Dr. William Emerson.

These results strikingly illustrate the soundness of the view expressed by Greenstein (7) when he said (p. 367): "It seems probable that a cancerous tissue can be described by a chemical pattern which is largely similar to that of nearly all other cancerous tissues regardless of their etiology, histogenesis, or even species wherein found." It would be hazardous to assume that *all* malignant cells, unlike the normal, metabolize guanine and therefore will become inhibited by guanazolo. But the fact that the first three types selected show the same biochemical difference from the normal cells would, on the basis of chance alone, offer fantastic odds in favor of uniformity, at least in this respect, among the various cancerous tissues.

Experiments are in progress with guanazolo on other types of malignancy, on the most effective dosages, on the effect of diet (purine intake) and on the effect of age of the tumor before the administration of the inhibitor. The details will be reported later.

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[5] Purchased from the Roscoe B. Jackson Memorial Laboratory.

[6] Sent to us by Dr. Lloyd W. Law of the National Cancer Institute.

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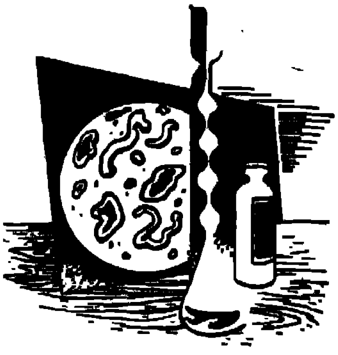

TECHNICAL PAPERS

Crystalline Dihydrostreptomycin Sulfate

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Dihydrostreptomycin (*1*) sulfate has now been crystallized. Crystals were first obtained by agitating and warming a concentrated aqueous solution of relatively pure dihydrostreptomycin sulfate with a large volume of methylethyl ketone. The lower aqueous phase was slowly converted from an oil to a gum, which finally crystallized. Subsequently, better crystallization procedures were developed in which methanol and other low-boiling solvents were substituted for the methylethyl ketone.

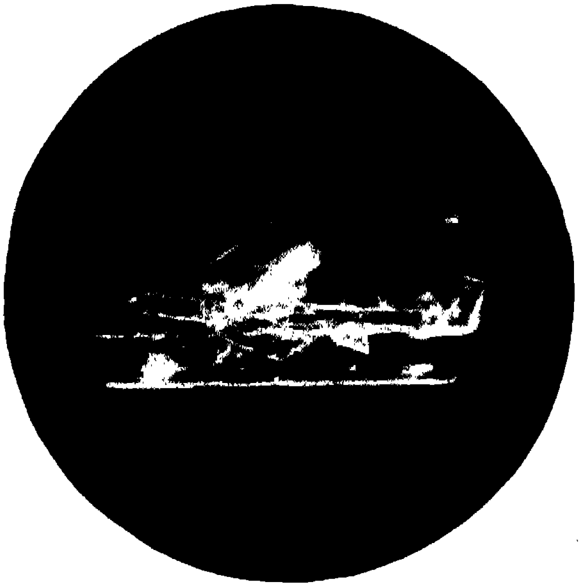

FIG. 1. Crystals of dihydrostreptomycin sulfate. Magnification 490 diameters.

Dihydrostreptomycin sulfate crystallizes as trapezoidal plates (Fig. 1). Two refractive indices of the crystalline material were found to be approximately 1.552 and 1.556. After recrystallizing and drying *in vacuo* at 100°, the anhydrous crystals melted at 255–265° (with decomposition), $[\alpha]_D^{25}$ – 88° (concentration, 1.0% in water). ***Analysis.*** Calculated for $(C_{21}H_{41}O_{12}N_7)_2 \cdot (H_2SO_4)_3$: C, 34.52; H, 6.07; N, 13.42; SO_4, 19.72. Found: C, 34.57; H, 6.23; N, 13.58; SO_4, 19.99.

The biological potency of the anhydrous crystalline dihydrostreptomycin sulfate, when assayed against *B. subtilis* by plate assay, was 815 γ/mg and against *E. coli* by turbidimetric methods was 820 γ/mg using the F.D.A. streptomycin working standard. By chemical assay using this same standard the potency was 830 γ/mg for streptidine and 0 γ/mg for maltol.

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Crystalline Salts of Dihydrostreptomycin

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Although a crystalline helianthate (*3*) and reineckate (*1*) of dihydrostreptomycin have been obtained, the preparation of crystalline salts suitable for therapeutic use has not been recorded. We wish to report at this time the preparation in crystalline form of the two currently used salts of dihydrostreptomycin, namely the hydrochloride and the sulfate.

Crystalline dihydrostreptomycin sulfate ($[\alpha]_D^{25} = -88.5°$, concentration = 1) is obtained as small platelets in almost quantitative yield from a solution of essentially pure amorphous sulfate (20 g) in 1: 3 methanol-water mixture (300 cc). The crystalline sulfate (mp 250° C, with decomposition) contains no solvent of crystallization and, in contrast to the amorphous form, shows very little hygroscopicity. Both the crystalline and the amorphous form are very soluble in water, but the crystalline sulfate is much less soluble (0.8 mg per ml) than the amorphous salt (100 mg per ml) in 50% methanol-water mixture. This low solubility of the crystalline sulfate in methanol-water mixtures makes possible the conversion of many dihydrostreptomycin salts to the crystalline sulfate by their metathesis with amine sulfates. *Analysis.* (Dried at 50° C.) Calculated for $(C_{21}H_{41}O_{12}N_7)_2 \cdot 3H_2SO_4$: C, 34.42; H, 6.05; N, 13.38; S, 6.56. Found: C, 34.26; H, 6.32; N, 13.27; S, 6.59.

By microscopic examination of the crystalline sulfate, the following characteristics were observed: *indices of refraction*, $\alpha = 1.552 \pm 0.002$; $\beta = 1.558 \pm 0.004$; $\gamma = 1.566 \pm 0.002$; *birefringence* (calculated) + 0.002; *axial angle*, 2V (calculated) – 89°; *extinction* parallel; *extinction angle* – 18°.

Using a Norelco Geiger counter X-ray spectrometer, major peaks were observed at the spacings 3.42 A (max); 3.62 A; 4.70 A; 4.78 A.

Crystalline dihydrostreptomycin hydrochloride is obtained in a 75% yield as fine needles from a solution of essentially pure amorphous salt (84 g) in methanol (260 cc). Crystallization is slow unless the solution is seeded and stirred gently. The crystalline hydrochloride is soluble in methanol at 25° C to the extent of 45 mg per ml, whereas the amorphous hydrochloride is soluble in excess of 1 g per ml. The crystalline product contains methanol, which is lost on heating at 100° C. The X-ray diffraction pattern of the methanol-free product exhibits major peaks at the spacings 3.75 A; 4.50 A (max); 4.90 A; 5.25 A; 8.85 A. *Analysis.* (Dried at 100° C.) Calculated for $C_{20}H_{41}O_{12}N_7 \cdot 3HCl$: C, 36.34; H, 6.39; N, 14.12; Cl, 15.33. Found: C, 36.21; H, 6.73; N, 13.89; Cl, 15.10. $[\alpha]_D^{25} = -95°$. Concentration = 1.

Microscopic examination of a sample dried at room temperature shows the following characteristics: *indices of refraction,* $\alpha = 1.522 \pm 0.002$; $\beta = 1.548 \pm 0.002$; $\gamma = 1.566 \pm 0.002$; *birefringence* -0.008; *axial angle,* 2V (calculated) 80°; *extinction* parallel; *sign of elongation* positive; *pleochromism* absent.

In general, the pharmacological properties of the crystalline salts are similar to those of the highly purified amorphous salts. However, certain impurities usually present in the amorphous salts are removed by the crystallization procedures, and consequently the batch-to-batch variation in the pharmacological response to the drugs observed in amorphous preparations has been eliminated in the crystalline salts (*2*).

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Special Sample Tray for the Continuous Gas-Flow Type Counter Tube[1]

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Because of recent interest in the continuous gas-flow type of counter tubes, an improvement in the sample tray for such a counter is presented. In order to reduce the length of time required to flush the counting chamber with gas, a modification of the counter was made to permit preflushing of the next sample to be counted while one sample is being counted.

The improved sample tray consists of a circular metal disk containing three receptacles for samples. These receptacles are symmetrically arranged so that while one is in the counting space, the second is in the preflush position, and the third is open to the atmosphere for sample changing. The flushing gas first enters the chamber of the counter, flows over the sample being counted, and then enters the preflush chamber, where the next sample to be counted is flushed, after which the gas is allowed to escape into the atmosphere. The construction permits rotation of the circular disk to allow a change in position of the samples. This chamber is overlaid with small lead cubes of sufficient thickness to prevent the sample in the preflush chamber from influencing the background count. If elements with high energy gamma emission are being studied, so that adequate lead shielding is impossible,

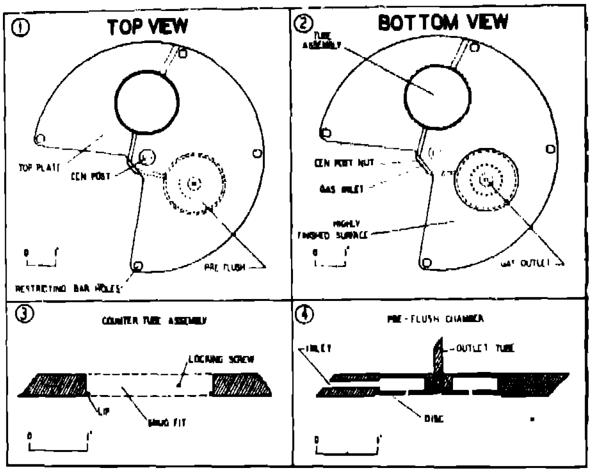

FIG. 1. Views showing the top stationary plate. The counter is fixed to one circular opening (Inserts 1, 2, and 3). The gas flows into the chamber of the counter, into the gas inlet and then into the "attic" of the preflush chamber (Inserts 1, 2, and 4), which is constructed to permit equal distribution of the gas before it escapes into the atmosphere through the outlet tube.

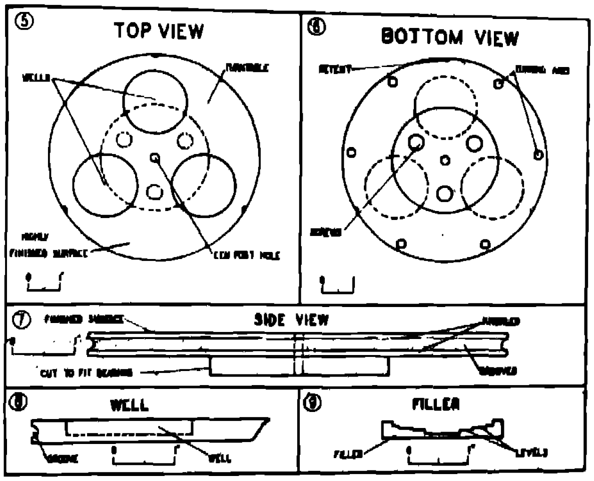

FIG. 2. Views of the turntable or sample tray with the 3 sample receptacles. This rides on a thrust ballbearing (Aetna E 45, 3½-in inside diameter, 5-7/32-in outside diameter, 1-in thickness). Insert 9 shows a brass filler which is placed in each receptacle. The fillers are cut to fit the sample trays or disks to insure their constant geometrical relationship.

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[1] Aided by grants from the Life Insurance Medical Research Fund, a War Contract No. WD-49-007-MD-369, and the Mrs. E. J. Caire Fund for Research in Heart Disease.

[2] The authors acknowledge with gratitude the excellent work of Mr. Ralph Millet, the instrument technician of the laboratory.

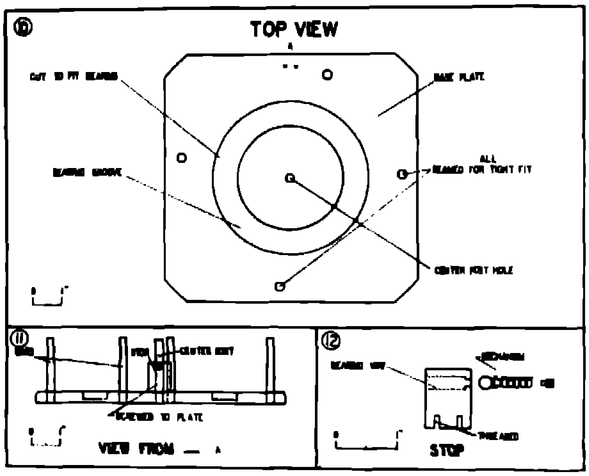

FIG. 3. Views of the base plate upon which the thrust bearing rests and to which is fixed the top plate shown in Fig. 1. The bars on pins (insert 11) are friction-fixed into this base plate but fit loosely into the top plate; the top plate is thus prevented from turning when the turntable or sample receptacle tray is rotated, but at the same time the top plate is permitted to ride freely upon and to seal the top of the turntable. The bearing surfaces between the top plate and sample tray are coated with a thick grease. A seal is further insured by the weight of the counter, top plate, and center post, which compresses a rubber washer against the center of the top plate, pressing it toward the bottom one.

then the preflushing feature is not used. Under such circumstances, the sample is rotated clockwise into the counter; sufficient time is then allowed for flushing and a count is obtained. The sample tray is rotated counterclockwise, so that its receptacle is brought to the outside for changing of samples.

Details of construction of the sample tray and its operation are evident from the illustrations. The plan may be modified to include automatic features.

Male Frogs and Toads as Test Animals for Early Pregnancy and Certain Related Conditions

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Very recently a large amount of evidence has been accumulated to show that males of Salientia can be unequivocally used to test for early human pregnancy (*1–5*). Mainini (*3*) has demonstrated for the first time, that in the males of the South American toad, *Bufo arenarum*, there occurs within 3 hr following injection a release of spermatozoa into the urinary bladder as a result of gonad-stimulating substances in the human pregnancy urine. Wiltberger and Miller (*5*) have confirmed, in the main, and extended Mainini's observations by using the common American leopard frog, *Rana pipiens*. Lima and Pereira (*2*) have also confirmed Mainini's test by using another toad, *Bufo marinus*. Again, while supporting claims made for this test by the above-mentioned workers, Haines (*1*), who used *B. arenarum*, which he received from the originator of the test, observes, "It remains to be seen whether *Bufo bufo* or *Rana temporaria* will be equally suitable." We have also been able to obtain a similar result by using the males of ordinary salientians that are easily available in Calcutta, namely, *Bufo melanostictus*, *B. stomaticus*, and *Rana tigerina*. Only a few specimens of each of the latter two species were employed for the confirmation of the results obtained in the former, which, however, was used chiefly during the course of our investigation.

In a series of urine tests run during the months of July to September, we obtained only positive results from the first and mid-trimester of pregnancy (Table 1). There was not even a single case of a false negative. Urine tested from the last trimester, however, gave 3 false negatives. This may be due to a low level of gonad-stimulating substances in the urine. Furthermore, both positive and negative tests were obtained from some individuals with related pathological conditions, such as hydatiform moles, superinvolutions, abortions, etc. The results of such tests tend to throw some light on the clinical aspects. Neither the control animals (the experimental animals also served as controls; their urine was examined for spermatozoa before they were injected with human urine), nor those injected with urines from nonpregnant or sterile women, or men, ever released spermatozoa.

TABLE 1

URINE TESTS FOR PREGNANCY AND OTHER CONDITIONS

Samples of urine	+	–	Total
Pregnancy—early (up to 90 days) ..	29	0	29
" —mid (from 91–180 days)	11	0	11
" —late (after 180 days) ..	26	3	29
Nonpregnancy	0	14	14
Sterility	0	14	14
Male	0	4	4
Pathological (abortions, mole, etc.) ..	9	20	29
Total	75	55	130

The technique employed in our series of tests is as simple as that of previous workers (*3, 5, 4*). In spite of our best efforts we could not secure early morning (overnight) urine, except for a few samples. The tests were based chiefly upon urines collected during late mornings and evenings, the identification not being known to us until after the tests. Our findings were afterwards clinically confirmed. Although a fresh toad was used for each urine test, a similar result could also be obtained from the same experimental animal after an interval of 4 to 7 days. One such animal could thus be re-used with success at least four times before it expired. A 5-cc dose of urine was uniformly administered, but if the test turned out to be negative, an additional dosage of 5 cc was administered 2 hr after the first injection, in order to corroborate the first result. In most cases a negative result was obtained even with a double dosage; only three samples of urine from the last trimester of pregnancy gave positive readings ½ hr after the second dosage of injection. Mention may also be made of the fact that a 2-cc injection of urine, or even 1-cc in a few cases, produced the same result as that obtained by a 5-cc injection, especially in those samples that gave strongly positive results. It appears from these observations that there may be some relation between the gonad-stimulating substances in urine and the liberation of spermatozoa. The results of 130 tests run in this laboratory are summarized briefly in Table 1.

It is interesting to note also that the time required for a positive reaction was only 25 min after the injection of urine in a large number of cases. Records of a few tests from the early trimester showed that a release of spermatozoa continued at intervals for 8 to 10 hr, completely disappearing after that period. The experimental animals were reexamined the next morning, but no spermatozoa were ever released with the voided urine. It cannot be stated with any degree of certainty whether there is seasonal variation, either in the duration or in the rapidity of the release of spermatozoa. Since Wiltberger and Miller (*5*) have stated that "the possibility of seasonal variation is still unknown," we hope to continue our tests during this winter. A detailed account of these and further tests will be published elsewhere.

It is apparent that our observations not only confirm, in the main, those in the most recent paper by Miller and Wiltberger (*4*), but also add some valuable data. Suffice it to say that the use of males of the Salientia as test animals for early pregnancy and certain related conditions will open a new chapter in the investigation of the biologic assay of urine hormones.

We wish to record our sincere thanks to Drs. G. Nandy, Binoy Banerjee, J. Chakravarty, and P. Das of Lake Medical College, Mrs. S. Ghosh of Baldeodas Maternity Hospital, and the authorities of Chittaranjan Seva Sadan, for generously providing us with specimens of urine.

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A Study of Native Species of Male Toads as Test Animals in the Diagnosis of Early Human Pregnancy

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After Galli-Mainini (*2*) in 1947 reported the use of the male South American toad, *Bufo arenarum* Hensel, in the routine diagnosis of early pregnancy, other investigators (*3, 4*) demonstrated that the male frog, *Rana pipiens*, responded to human pregnancy urine in a manner similar to that of the South American toad, namely the rapid release of spermatozoa.

Impressed by the simplicity and economy of this test, we became interested in the possibility that species of male toads native to the Rocky Mountain area might serve as satisfactory test animals. Two species have been tested, *Bufo woodhousii* of Girard, the most widely distributed species of toad in Colorado, and *Bufo americanus*, the common toad of North America. In this region these animals offer the advantages of being more hardy and easier to keep than frogs.

Our technique has been simple, consisting of the injection of 5 cc of untreated urine into the dorsal lymph sac of the animal. We then obtain a specimen of toad urine 3 hr later by the introduction of the tip of a small (1 cc) pipette into the cloacal orifice. The specimen is examined unstained under the low power of a microscope for the presence or absence of the numerous motile, thread-like spermatozoa. If these are absent, specimens are again examined at 5 and 24 hr. Animals may be used again after a rest period of one week.

We have performed a total of 145 tests to this date. Five animals have died as a result of the injection. There were 75 negative results and 65 positive results. In no case did a urine from a nonpregnant patient give a positive result. In 69 Friedman or Aschheim-Zondek and toad tests performed coincidentally, there was one disagreement, a negative toad test and a positive Friedman. The patient could not be followed to ascertain which was correct. Remaining tests were performed on specimens obtained from patients seen in Colorado General Hospital Outpatient Department suspected of early pregnancy. All results in these cases were proven correct by clinical followup. The earliest positive result was obtained only 8 days after the first missed menstrual period. Urine specimens obtained from women past the sixth month of pregnancy gave false negatives in 2 out of 5 specimens tested, confirming the unreliability of this test in late pregnancy as reported by workers using the South American toad (*2*) and the frog (*3*).

A urine specimen from a patient with hydatidiform mole was tested. It gave a positive result in a dilution of 0.05 cc. Basing our calculation on the observation that these animals have responded to a minimum of 10 rat units of a commercial preparation of chorionic gonadotropin, we estimated that there were at least 200,000 rat units of gonadotropin per liter in this specimen, a level consistent with the diagnosis of mole.

These native toads have been used up to 8 times with no apparent decrease in accuracy. An effect of repeated injections seems to be the slowing of reaction time. On the first injection all positive results were evident within 3 hr. However, on further injection, spermatozoa did not appear until 5 hr in nine positive tests, and until 24 hr in four such tests out of a total of 50 positive results in animals injected more than once. *Bufo americanus* was used in 18 tests and *Bufo woodhousii* Girard in the remaining 127 tests. The one discrepancy between toad and Friedman tests occurred in *Bufo woodhousii* Girard.

The fact that these two native species of toads, as well as several South American toads and the frog, *Rana pipiens*, respond to the injection of urine from pregnant patients by the rapid release of spermatozoa would seem to indicate that this reaction is generalized in toads and frogs and that it offers a practical means of testing for early human pregnancy.

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Vacuum-Paraffin Infiltrator

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The need for a method which would infiltrate a whole rat brain with paraffin was the basis for development of the vacuum-paraffin infiltrator,[1] an electrical heating unit which contains a glass bottle connected to a vacuum source. The heat in the bottle is controlled by a rheostat which regulates the flow of current into the heating unit.

The procedure followed in developing the infiltrator was first to select a suitable glass bottle. A copper cup was formed into which the bottle was placed so that there was a close sliding fit between bottle and cup. A thin sheet of asbestos paper was wrapped around the metal cup to form a base upon which the high resistant wire was wound. The wire used was 24 gauge chromel "A" asbestos-covered wire. Care must be taken in winding the wire to reduce the hazard of short circuit. A piece of copper tubing was fitted over the coils, and holes were drilled into the tubing so that dissipation of excess heat would be more effective, thereby preventing the contents of the glass bottle from becoming overheated. The wire coil of the heating unit was attached to two contact poles which were incorporated into a wood base facilitating use of a plug to connect the rheostat.

The rheostat, similar to ready-made ones, was designed to be more adaptable to control of the heating unit. Buttons on the control dial of the rheostat were connected at various points of the resistance wire, thereby cutting in or cutting out more or less resistance. A small Christmas tree light was added to the rheostat. It lights up when the switch is on, and dims or brightens as the control knob of the rheostat is turned from button to button; the brighter the light, the higher the temperature in the heating unit. This feature is a valuable aid in indicating whether the circuit is operating properly. If the heating unit wire develops a break, the light will not dim or brighten to the same degree when the control knob is passed over the buttons of the rheostat.

The vacuum source is a conventional water aspirator which is attached to a water faucet. A two-holed rubber stopper is used in the bottle of this model, one hole containing the glass tubing for the vacuum connection and the other containing a thermometer which is used to make an occasional check on the temperature of the paraffin.

The advantage of this vacuum-paraffin infiltrator is that it can be set into operation and left without need for constant attention. It has also been found that resulting paraffin tissue blocks are more compact, due to the low air content of the paraffin. If the clearing agent is a comparatively volatile substance, its removal is expedited by this method. By keeping the paraffin free of the clearing agent, the necessity of having two or three changes of paraffin is eliminated.

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[1] The author extends his appreciation to E. Ehrlich, Sr. for technical assistance in producing this model.

The Effect of Supervoltage Cathode Rays on the Nonenzymatic Browning Reaction of Dried Fruits and on Chemical Compounds Pertaining Thereto

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It has been demonstrated previously that ionizing radiations have a lethal action on bacteria and thus may offer a potential means of processing foods (*1, 3*). To determine the feasibility of using these radiations in the preservation of foods, the effects of the radiations on the nutrients in foods, on color components, and on flavor are under investigation in these laboratories.

The experiments described herein relate to some observations made on the effects of high voltage cathode rays, electrostatically produced, on color in dried fruits, extracts thereof, and compounds pertaining thereto. The cathode rays utilized in this work were obtained from a Trump Generator (*6, 7*) operating at 3,000 kv.[1]

Dried prunes were exposed to cathode ray irradiation for dosages up to 10 million roentgen-equivalents-physical (rep). A definite bleaching of the flesh was observed in prunes that were examined immediately after irradiation, but no color changes in the skin were noted. The amount of bleaching increased with greater dosages of radiation. After the prunes had been at room temperature (70°–80° F) for two weeks, the color of the flesh appeared to have returned to normal. No noticeable change was observed in the flavor of the prunes immediately after irradiation or two weeks later.

A similar experiment was carried out with Thompson Seedless Raisins. With raisins, however, bleaching occurred in the skin as well as in the flesh, and a definite off-taste was noted. As in the case of the prunes, the

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[1] The authors are grateful to Dr. John G. Trump and Mr. Kenneth A. Wright of the Department of Electrical Engineering, Massachusetts Institute of Technology, for their cooperation in making available the Trump Generator.

color returned to normal after the raisins had been held approximately two weeks at room temperature.

To determine quantitatively the effects of ionizing radiations on prunes, samples of prune juice were irradiated by high voltage cathode rays with dosages of 10,000,000 rep. Visible absorption spectra were determined on both control and irradiated samples immediately after irradiation and after standing at room temperature for 20 hr. Ultraviolet absorption spectra were also determined on both control and irradiated samples immediately after irradiation and also upon standing 20 hr. These are presented in Fig. 1. The prune juice was bleached by the ionizing radiations, and there was a partial return of color after the samples had stood 20 hr. The color changes are presented in Table 1. The amount of color was obtained by integration of the transmission curve (*4*). The shapes of the visible absorption spectra curves, plotted as extinction referred to wavelength, were similar.

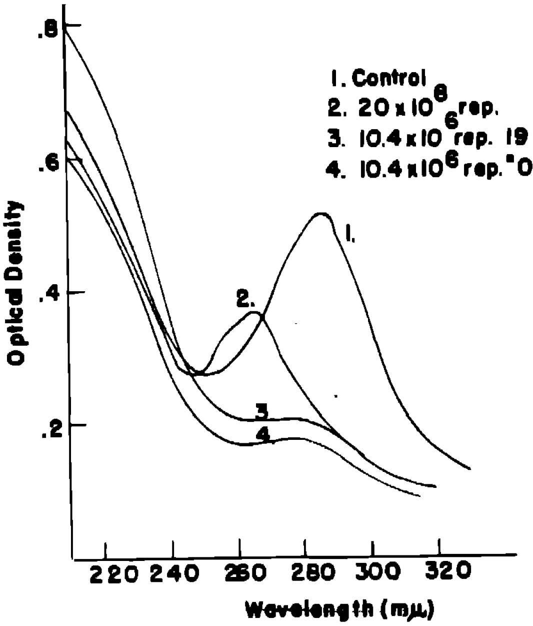


FIG. 1. The ultraviolet absorption spectrum of prune juice irradiated by cathode rays and allowed to stand at room temperature for 19 hours.

TABLE 1

EFFECT OF HIGH VOLTAGE CATHODE RAYS ON COLOR OF PRUNE JUICE

Sample	Hours standing after irradiation*	Color	
		Arbitrary units	% of control sample
Control	...	605	100
Irradiated	0	80	13.2
"	4.5	165	28.2
"	20	280	46.3

* At room temperature.

Fig. 1 indicates that prune juice has a maximum absorption at 285 mμ, suggesting 5-(hydroxymethyl)-furfuraldehyde (HMF), one of several compounds to which the brown color of dried fruits has been attributed (*5*). Upon irradiation, there is a drop in this peak and no significant return to this maximum with a lapse of 20 hr. Irradiation of prune juice by 20,000,000 rep. of cathode rays results in an entirely different curve, with an absorption maximum at 265 mμ.

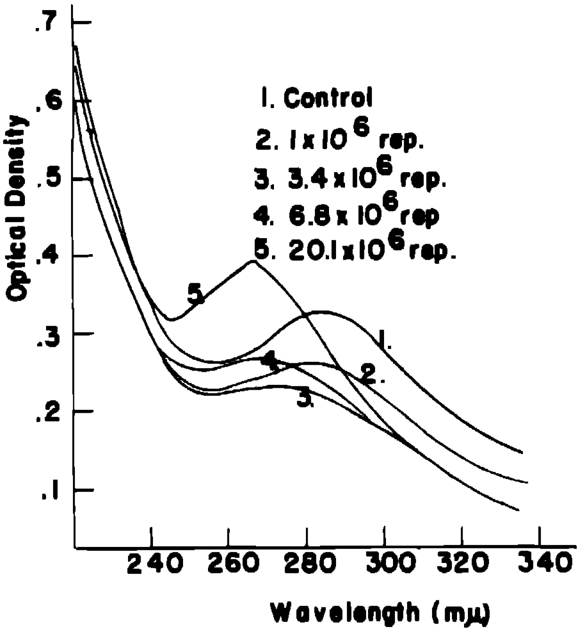


FIG. 2. The ultraviolet absorption spectrum of a browned apricot extract irradiated by cathode rays for dosages up to 20.1×10^6 rep.

Since Fricke (*2*) has shown that ionizing radiations result in the production of small quantities of hydrogen peroxide, it was deemed desirous to react some hydrogen peroxide with prune juice to determine whether this reaction causes bleaching and changes in ultraviolet absorption spectrum. A solution of 25 ml of prune juice and 5 ml of 3% hydrogen peroxide was allowed to react for 5 min at room temperature. Samples of the solution were then diluted for determination of visible absorption

TABLE 2

EFFECT OF HIGH VOLTAGE CATHODE RAYS ON COLOR OF BROWNED APRICOT EXTRACT

Sample	Hours standing after irradiation*	Color	
		Arbitrary units	% of control sample
Control	..	380	100
Irradiated	0	30	7.9
"	18	120	31.6
"	35	240	63.2

* At room temperature.

and ultraviolet absorption spectra. No change in color or in ultraviolet absorption spectrum was observed in the peroxide-treated juice as compared with the control. Even with extreme treatment when 25 ml of 33% hydrogen peroxide was combined with 25 ml of prune juice, there was no change in color. It would appear, therefore, that the bleaching of prune juice by supervoltage cathode rays and the change in the ultraviolet absorption spectrum are not ascribable to the peroxide alone.

These data strongly suggest that HMF is destroyed when prune juice is irradiated and, coincidentally, the color of the prune juice disappears. When the color of the irradiated juice partially returns upon standing, the ultraviolet absorption spectrum remains unchanged.

A similar experiment was run on an apricot extract made from dried apricots that had browned on previous storage. The results obtained with the apricot extract were similar to those noted with the prune juice. Upon standing of the extract, there was no change in the ultraviolet absorption spectra (Fig. 2), but there was a partial return of the color (Table 2).

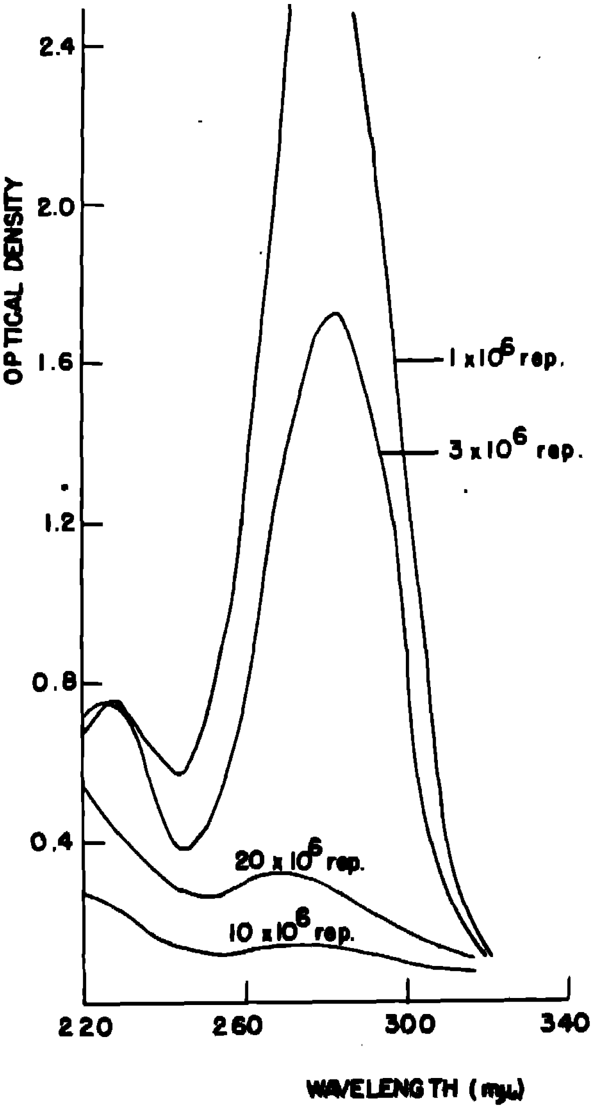
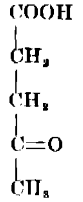


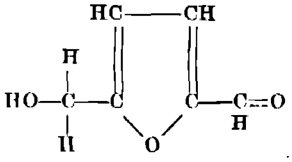
Fig. 3. Effect of high voltage cathode rays on ultraviolet absorption spectrum of 5-(hydroxymethyl) furfural.

Pure solutions of furfural, furfuryl alcohol, and furoic acid were irradiated by cathode rays, in an attempt to determine the chemical changes taking place when browned fruit extracts are irradiated by high voltage cathode rays, and also to determine whether other members of the furan series of compounds might be involved. A pure solution of HMF[3] was also irradiated by cathode rays, and the ultraviolet absorption spectra of this solution are presented in Fig. 3. Solutions of glucose, fructose, and sucrose—0.5%, 0.5%, and 1.0%, respectively—in N/1 sulfuric acid, boiled for 4 min, were irradiated also by cathode rays.

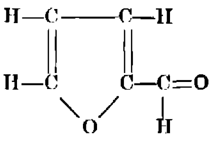
To facilitate the comparison of the absorption spectra obtained for the chemicals mentioned, their structural formulas are given below.



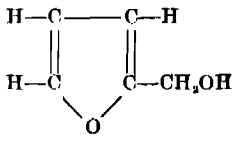
Levulinic Acid



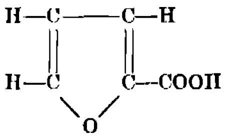
5-(Hydroxy methyl) Furfural



Furfural



Furfuryl Alcohol



Furoic Acid

In the case of the homologues of HMF, namely, furoic acid, furfuryl alcohol, and furfural, there was no shift in absorption maximum upon irradiation. In all three cases, only an increasing loss in extinction occurred. In the case of HMF, there was a progressive loss of the peak at 285 mμ with lower dosages of radiation and the gradual formation of a new peak at 265 mμ. The acid-treated sugar solutions reacted to irradiation exactly like the HMF, showing a loss of peak at 285 mμ and the formation of a new peak at 265 mμ upon greater dosages of radiation. This peak at 265 mμ coincides with that of levulinic acid (*4*).

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[3] The authors are grateful to Dr. Gordon Mackinney, Food Technology Division, University of California, for generously supplying them with the HMF synthesized by him.

These data suggest that HMF in pure solution may be, at least in part, converted by high voltage cathode rays into a compound or compounds having an absorption maximum at 265 mμ, one of which may be levulinic acid. The formation of the resulting compound or compounds does not proceed from the other three homologues of HMF when they are irradiated. A similar shift in absorption maximum was noted when browned dried fruit extracts were irradiated by high voltage cathode rays.

Levulinic acid has an extinction coefficient one thousandth that of HMF. If the compound absorbing at 265 mμ were solely levulinic acid, it would appear from these data that there was not sufficient HMF present to account for all the levulinic acid and that some of the levulinic acid must have been formed by the action of cathode rays from other compounds in the solution.

Although HMF may be associated with the brown color in dried fruits, it is reasonable to assume that, upon irradiation, it is converted irreversibly into a compound that absorbs maximally at 265 mμ, probably levulinic acid. Yet upon standing, most of the color returns. This confirms previous suggestions (*5*) that other as yet unidentified compounds may share the responsibility for the nonenzymatic browning of dried fruits.

Further experiments using supervoltage cathode rays as a tool for the investigation of chemical changes in foods are currently in progress.

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Pyrolysis of Diphenyl Disulphide and the Formation of Free Radicals containing Univalent Sulphur

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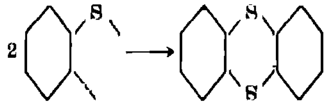
Contrary to views previously accepted (*1*), it has been pointed out by Schönberg (*2*) that diphenyl disulphide (I) and related substances are capable of forming free arylthial radicals in hot solutions (cf. I ⇌ 2 II). The cracking of diphenyl disulphide has now been investigated and carried out in the absence of a solvent and of oxygen in such a way that the reaction products of lower boiling point were allowed to distill off during the thermal decomposition (288° bath temperature; six hr). From diphenyl disulphide (5.5 g) an oily distillate was obtained which had the properties of thiophenol and yielded its benzoyl derivative (1.95 g) when treated with benzoyl chloride in the presence of alkali. The contents of the reaction vessel solidified and after recrystallization, diphenylene disulphide (thianthrene—III) was obtained. The thermal decomposition of diphenyl disulphide follows the same principle (disproportionation) as that which is operative in the case of tetraphenyl hydrazine (*3*) (IV) leading to the formation of diphenyl amine (VI) and diphenyl dihydrophenazine (VII).

This analogy is a further indication that diphenyl disulphide forms free radicals at high temperature (II) as do the tetraarylhydrazines (cf. V).

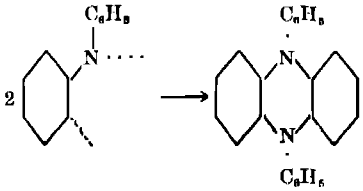
$$\underset{\text{I}}{2C_6H_5\cdot S\cdot S\cdot C_6H_5} \xrightarrow{\text{heat}} \underset{\text{II}}{4C_6H_5S\cdots} \longrightarrow 2C_6H_5SH +$$



III

$$\underset{\text{IV}}{2(C_6H_5)_2N\cdot N(C_6H_5)_2} \xrightarrow{\text{heat}}$$

$$\underset{\text{V}}{4(C_6H_5)_2N\cdots\cdot} \longrightarrow \underset{\text{VI}}{2(C_6H_5)_2NH} +$$



VII

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Nicotinic Acid as a Growth Factor for Certain Orchid Embryos

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The problem of possible symbiotic relationships between orchids and their naturally occurring mycorrhizal symbionts has been under dispute ever since Knudson (*6*) cultured orchid embryos on an aseptic agar, inorganic salt, and sucrose medium in the absence of any fungus. However, Knudson (*7*) agreed with Bernard (*2*) and Burgeff (*3*) that orchid embryos attained better development when cultured with the mycorrhiza. Yet since this association was not absolutely essential, he believed symbiosis was doubtful.

Later Burgeff (*4*) claimed that *Cattleya* embryos were more autotrophic than *Vanda*. He showed that the embryos of *Vanda* developed poorly in the absence of *Rhizoctonia mucoroides*, their specific symbiont, although in its presence they germinated and grew well. An extract of the dead fungus was just as successful in promoting growth, and the active principle formed for the seedling by the fungus was a growth factor resembling bios II. The mycorrhizal fungus has been shown by Schopfer (*9*) to be autotrophic for all essential growth substances except carbohydrates. Stimulation of orchid embryo growth with extracts of seeds, leaves, roots, and yeast was determined by Schaffstein (*8*). He also found that estrone, biotin, thiamine, riboflavin, vitamin A, and vitamin D would not replace the plant extracts.

The inference from the foregoing that orchid embryos and seedlings obtain part of their essential organic nutrients from the mycorrhizal fungus with which they are associated in nature, prompted an investigation of the growth factor requirements of orchid embryos.

In an initial series of experiments a basic medium composed of inorganic salt (*1*), sucrose, and agar was employed as a control, to which was added a solution containing certain growth factors found optimum for the development of very young *Datura* embryos by Van Overbeek *et al.* (*10*). On these media, undifferentiated orchid embryos approximately 0.45 mm long by 0.1 mm wide were cultured. The increased growth response of the seedlings in the cultures treated with the growth factor supplement, as compared with the controls is shown in Table 1.

TABLE 1

EFFECT OF ORGANIC SUPPLEMENTS* TO NUTRIENT SOLUTION ON DEVELOPMENT OF ORCHID EMBRYOS

Genus	Size after 12 months mm		Final pH of media	
	Control†	*Treated*	*Control*	*Treated*
Brassocattleya hybrid	1.0– 1.5	15.0–20.0	5.2	6.1
Cattleya hybrid	2.0–10.0	25.0–32.0	5.0	4.9
Vanda Miss Joaquim	10.0–20.0	35.0–50.0	4.5	3.7

* Concentration of growth factors are those found satisfactory for *Datura* by Van Overbeek *et al.* (*10*), and are as follows in mg/l: calcium pantothenate, 0.5; adenine, 0.2; succinic acid, 25.0; glycine, 3.0; pyridoxine hydrochloride, 0.2; thiamin hydrochloride, 0.15; asparagine, 3.0; ascorbic acid, 20.0; nicotinic acid, 1.0. Mixture has pH 3.2.

† Basic medium: Arnon's (*1*) 2-salt solution with micronutrients added; 1.5% agar, 2% sucrose, adjusted to a pH of 5.0 after autoclaving. All cultures incubated in diffuse sunlight at 28° C. Final pH indicates effect of absorption and growth of the embryos on the reaction of the media.

The contrast in Table 1 represents the average of five replications. The length of each seedling was measured from tip of root to tip of shoot. The difference of 13–40 mm growth with addition of organic nutrients in the genera used shows the deficiency of one or more factors for optimum development.

The next experiment was designed to emphasize the effect of the individual vitamins employed. The same technique and concentrations were used as in the first experiment. Vitamins B_1, B_6, C, calcium pantothenate, and nicotinic acid were added singly to cultures containing the previously described basic medium. Riboflavin was also included in this series at 0.2 mg/l. Preliminary results, obtained from culturing embryos of the genus *Vanda Miss Joaquim* with various vitamin treatments for 26 weeks, indicate that the *Vanda* embryo suffers from a lack of nicotinic acid (Table 2). The possible beneficial effects of pantothenate, riboflavin, pyridoxine, ascorbic acid, and thiamine are questionable.

TABLE 2

GROWTH OF *Vanda* EMBRYOS CULTURED 26 WEEKS

Treatment*	Average total length† mm	Final pH of media
Control—basic medium	10.0–15.0	5.2
Nicotinic acid 1 mg/l added	20.0–30.0	3.8

* Basic medium and environmental conditions the same as in Table 1.

† Typical of five replicates, 200–300 plants each.

The stimulation of orchid embryo growth with the addition of nicotinic acid, as shown in Table 2, and the similar activation by the mycorrhizal fungus, suggest one of the possible symbiotic functions of the fungal organism, especially since Schopfer (*9*) and Burgeff (*5*) have shown that it is autotrophic for nicotinic acid.

Investigations under way suggest that the very low respiratory rate for orchid embryos (as contrasted with barley embryos), is not increased by additions of nicotinic acid. Detailed data concerning these experiments will be presented later.

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Comments and Communications

Traveling Waves in the Brain[1]

In an earlier paper (Goldman, S., Vivian, W. E., Chien, C. K., and Bowes, H. N., *Science*, 1948, 108, 720) equipment for electronic mapping of the electrical potential at the surface of the skull has been described. In this paper it was stated that area displays of the instantaneous skull potentials could not readily be interpreted because of the speed of the activity. Subsequent work in cleaning up residual artifacts has clarified these pictures. The taking of motion pictures of the activity and their display at slow motion (by a 4: 1 ratio) has added further information, so that it is now possible to give a first report of the results.

In the observed area displays, there is some activity of rise and fall in potentials, which apparently occurs at irregular times at isolated electrodes. Less frequently the activity of a large part of one of the hemispheres of the brain seems correlated. The most striking activity, however, is that of traveling waves across the skull. Some traveling waves cross the entire skull, often crossing the central fissure. If all sixteen electrodes are placed above the general outline of a single occipital or temporal lobe of the brain, it may be seen that there are traveling waves within the single lobe. In a single lobe the traveling waves often show a rotational (or circular) path which has never been noticed in the case of waves crossing larger areas of the brain. Within the same lobe there are successively clockwise and counterclockwise rotations, interspersed with straight motions at various angles. The frequency of rotation of the rotatory motion is approximately 9 per sec.

The traveling wave phenomena are much more pronounced when the eyes are closed than when they are open. It was therefore thought at first that the single lobe effects, such as rotational motion, might be characteristic only of the occipital lobes, where they were first observed. This, however, turned out not to be true, since the same type of single lobe phenomena, including rotational motion (but of reduced voltage), occurs also in the temporal lobes. Surprisingly enough, the traveling wave activity in the temporal lobes also becomes much more pronounced when the eyes are closed. This would appear to indicate that when the eyes are closed in a wide-awake individual (holding the hands in front of the open eyes to keep out light has the same effect as closing the eyes), the entire brain changes its type of activity, becoming more active internally. If the individual becomes drowsy, the amplitude of the traveling wave activity is greatly decreased. No characteristic individual activity was observable in the frontal lobes.

Tests were made with visual and auditory stimuli to see whether they gave rise to traveling waves. In the case of an auditory stimulus, an effect could be observed in the pattern, but it was stationary and localized. No effect whatever could be observed in the pattern when a visual stimulus was brought into the field of vision. This was undoubtedly due in part to the crudeness of the test.

The major part, at least, of the traveling waves may be identified with the alpha rhythm. This is indicated by their frequency and their variation of intensity with time, and with opening and closing of the eyes. The suggestion, often made, that the alpha rhythm represents a scanning operation in the brain appears, as a gross interpretation, to be borne out by the observed pictures. This is particularly true for the single lobe pictures, as might be expected. We have, however, no experimental information as to the physiological nature of this operation, nor do we yet really know that the fundamental nature of these traveling waves is that of a scanning process.

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Weston E. Vivian, and Douglas Goldman
Research Laboratory of Electronics,
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Louisiana Oyster Production

In a recent article (*Science*, 1948, 108, 484) the writer made the following points: the Fish and Wildlife Service has not collected annual fishery statistics on the Gulf Coast every year due to lack of funds; the federal oyster statistics prior to 1930 are about 35% exaggerated when given in pounds; state and federal statistics show no evidence of decline in Louisiana oyster production; oyster production of other Gulf states combined has declined 78% since the 1920's; and the misgivings expressed by Walter A. Chipman, Jr. (Oyster Institute of North America Trade Report No. 91, June, 1948; mimeographed) over the threatened "existence of the large oyster industry of that state" (Louisiana) were unfounded.

In a rather curious reply, which avoids mention of the points I made, Chipman (*Science*, 1949, 109, 210) says, "Even though the total production remains stable or actually increases, it must be realized that this situation results from expansion of the industry through use of undeveloped grounds, of which Louisiana has an abundance, and of better utilization of producing grounds. It does not negate the fact that a continuing unexplained mortality may prevent the production from reaching even higher levels. Furthermore, once the expansion is completed, this mortality may then result in decline as the adverse factors causing this mortality continue and spread to other areas. This latter possibility has been in the minds of Louisiana oyster conservationists for some time. Because they are progressive and look into the future, they have good reason for alarm."

This contradicts none of the facts I previously presented. Alarm over the failure of the Louisiana oyster industry to increase is interesting, but not contradictory to the statement that it has not declined in total production. The fact that an industry does not increase its production can scarcely be advanced as evidence of its endangered existence. If Louisiana oystermen are making better utilization of producing grounds and expanding onto abundant undeveloped grounds, as Dr. Chipman states, then it would seem that fears for the future are needless. Since he has this view, objections to my less sanguine statement that there is no evidence of production decline are inconsistent and contradictory.

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[1] This research has been supported in part by the Signal Corps, the Air Materiel Command, and the Office of Naval Research.

It is quite true, as Chipman points out, that serious mortalities have occurred from time to time. Mortalities of oysters and other animals, catastrophic and otherwise, are well known phenomena on the Gulf Coast and such information has been published 45 years and more, but it is an exaggeration to say that mortality "threatens the very existence" of Louisiana's oyster industry. There is no evidence of decline in production of the Louisiana oyster industry. Unfortunately, however, the condition of the oyster industry in Texas is more serious, and Chipman's fears would be more appropriate there. In 1904 Texas produced 199,000 barrels of oysters. In the fiscal year 1947–48 only 23,000 barrels were produced, a decline of 88%, which has not yet been stemmed. Louisiana is the only Gulf state in which oyster production has not declined.

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Thiamin or Thiamine?

Periodically I am asked whether vitamin B_1 should be referred to as "thiamin" or "thiamine." The following history may be of interest to some readers.

I suggested "thiamin" in 1937 in response to a request from the Council on Pharmacy and Chemistry of the American Medical Association. This was adopted (see *J. Amer. med. Ass.* 1937, 109, 952). The name so appeared in this journal and in other publications of the AMA for two or three years, including the 1940 edition of "New and Non-Official Remedies."

Under date of July 3, 1939, E. Fullerton Cook, chairman of the Committee of Revision of the Pharmacopoeia of the United States, wrote me a letter which included the following paragraph:

> You may wonder why the Pharmacopoeia has suggested the use of this title, when "Thiamin Chloride" had already been widely used. The Pharmacopoeial group recognized that Thiamine Hydrochloride had, essentially, the characteristics of an alkaloid, and the use of the final "e" and "Hydrochloride" rather than "chloride" when the hydrochloride radical is attached, is in strict accordance with our rules for nomenclature. Of course we would add "Thiamin Chloride" as a synonym, at Dr. Nelson's suggestion.

The spelling "thiamine" was adopted for the second U. S. Pharmacopoeia XI Supplement and has since been accepted by *Chemical Abstracts, Journal of Biological Chemistry, Journal of the American Medical Association* (including the 1948 edition of "New and Non-Official Remedies"), and other publications.

"Thiamine" must now be accepted as the approved spelling.

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Freezing Laboratory Materials for Plant Science

The routine practices of drying plant materials for taxonomic and morphological studies, or preserving them in various chemical solutions, have many disadvantages. Neither method is adequate for color preservation. The formaldehyde vapor method, which preserves well, has a disadvantage in that some people are sensitive to formaldehyde. When an early frost line threatened in the fall of 1947 I collected flowers, packaged them in lined paper bags of the type sold for food processing, and placed them in a commercial deep freeze locker. This procedure proved so successful that I made extensive collections the following summer. By merely packaging specimens while they are fresh, and transferring them to the deep freeze, one can readily provide a wide range of material for subsequent classroom needs.

Some flowers and plant materials lend themselves more successfully than others to this treatment but even the most delicate, such as *Impatiens pallida* Nutt., retain enough color and form to be useful for the duration of a two-hour laboratory period. Even if the color alters upon prolonged exposure to room temperature, the form of the flower remains intact. Keeping such material covered in culture chambers until it is needed helps maintain the natural form. Other plants emerge in a remarkably fresh condition, with scarcely any alteration, even after several hours. Some of the flowers which have given especially good results are: *Phleum pratense* L. and other species of grass, *Eriocaulon septangulare* L., *Phytolacca decandra* L., *Polygonum pennsylvanicum* L., *Chenopodium album* L., *Potentilla fruticosa* L., *Cassia marilandica* L., *Sambucus canadensis* L., *Plantago major* L. and *P. lanceolata* L., *Ligustrum vulgare* L., *Asclepias syriaca* L., *Clethra alnifolia* L., *Kalmia latifolia* L. and cultivated species of *Azalea* and *Rhododendron*, *Euonymus japonica* L., *Daucus carota* L., *Tilia americana* L., *Achillea millefolium* L. and other species of Compositae.

Other plant materials that have been particularly useful for subsequent studies during the year include the hips of *Rosa rugosa* Thunb. These have been successfully used for lycopene extraction, structural studies of the chromoplasts, and for vitamin C analysis using the method recommended by Tuba *et al.* (Tuba, Jules, Hunter, G., and Osborne, J. A., *Canad. J. Res.*, 1946, 24, 182). Even after many months of storage, an excellent reaction for ascorbic acid granules in the cells may be obtained.

The freezing method seems to offer a valuable means for having available a wide range of seasonal materials at all times.

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Vassar College

NEWS and Notes

Gerd Enequist, specialist in geocultural and geo-economic science, has been named professor of geography at Upsala University, Sweden. Dr. Enequist is the first woman ever appointed to the faculty of the 500-year-old university.

William B. Wartman, chairman of the Department of Pathology, Northwestern University Medical School, will deliver the 25th Ludvig Hektoen Lecture of the Frank Billings Foundation, Institute of Medicine, Chicago, at the Palmer House, on the evening of May 27. His subject will be "Bleeding into the Arterial Wall: Its Relation to Vascular Disease."

Carl C. Chambers, professor of electrical engineering, has been named acting dean of the University of Pennsylvania's Moore School of Electrical Engineering. He will replace **Harold Pender**, who is retiring July 1, after holding the deanship since 1923.

James C. Stewart, project engineer for the Oak Ridge National Laboratory, has been appointed manager of the Schenectady area office of the U. S. Atomic Energy Commission; he will replace **Leonard E. Johnston**.

Wilbur H. Duncan, field botanist at the University of Georgia, will deliver a lecture entitled "The Field is My Laboratory" at the annual Sigma Xi Initiation Banquet at the University of Georgia on May 25.

Roy S. Glasgow, chairman of the Department of Electrical Engineering at Washington University, St. Louis, will become civilian head of the Naval Postgraduate School at Annapolis, on July 1. He will succeed **Ford L. Wilkinson**, who resigned last December to become president of Rose Polytechnic Institute, Terre Haute, Indiana.

Donald Paul Costello, chairman of the Department of Zoology at the University of North Carolina, has been appointed Kenan Professor of Zoology.

Elwood C. Zimmerman, associate entomologist at the Experiment Station of the Hawaiian Sugar Planters' Association and curator of entomology, Bishop Museum, left Honolulu on May 8 for the British Museum of Natural History. Dr. Zimmerman will spend a year continuing work on his series of volumes *Insects of Hawaii*. The first five volumes of the monograph were issued in 1948.

Henry Mann, former professor of mathematics at Ohio State University, has been appointed to the staff of the Applied Mathematics Laboratories of the National Bureau of Standards. He will head a project to develop a theory of stochastic (random) processes capable of utilizing modern principles and techniques of statistical inference.

Grants and Awards

Walter Davis Lambert, recently retired chief of the Section of Gravity and Astronomy, U. S. Coast and Geodetic Survey, has been awarded the William Bowie Medal for his leadership in the study of earth sciences. He became the 11th recipient of the award, presented annually by the American Geophysical Union.

Kenneth L. Brown, E. Paul Budewitz, and **Earl E. Myers** have been appointed to Sherwin-Williams Graduate Fellowships in Organic Chemistry at Western Reserve University for the academic year 1949–50.

Austin M. Patterson, former vice president of Antioch College, has been granted a new award in the Documentation of Chemistry by the Dayton Section of the American Chemical Society.

O. R. Quayle, professor of chemistry at Emory University, has been awarded the Herty Medal given annually by the Chemistry Club of the Georgia State College for Women for outstanding service in the field of chemistry.

The Department of Agriculture presented its 1949 honor awards at its annual ceremony, held May 16 in Washington, D. C. The five recipients of the Distinguished Service Awards are: **Elmer W. Brandes**, Bureau of Plant Industry, Soils, and Agricultural Engineering, Beltsville, Maryland, for leadership in the development and administration of research programs for sugar cane, sugar beets, and rubber, and for fundamental research on the cause and control of sugar cane mosaic; **Charles A. Cary**, Bureau of Dairy Industry, Beltsville, Maryland, for contributions to the knowledge of the composition and nutritional properties of milk, including the discovery of the presence of the B-12 vitamin; **Edgar S. McFadden**, Bureau of Plant Industry, Soils, and Agricultural Engineering, College Station, Texas, for his contribution to agriculture through the development of Hope wheat, the original rust-resistant variety and the source of resistance for other varieties; **Leslie J. Sullivan**, Forest Service, Olympia, Washington, for heroism beyond the call of duty which resulted in saving the life of a co-worker; and **Claude R. Wickard**, Rural Electrification Administration, Washington, D. C., for his contribution to the enrichment of rural life through his advocacy of scientific farming.

Colleges and Universities

A gift of $1,000,000 to establish an Institute of Microbiology has been given to **Rutgers University** by Selman A. Waksman, Rutgers alumnus, and faculty member for over 25 years. Dr. Waksman, who discovered streptomycin, has assigned his patent to the Rutgers Research and Endowment Foundation. Royalties will be used to build and operate the new Institute and Dr. Waksman will be its first director.

The Hebrew University-Hadassah Medical School, was opened May 17 in Jerusalem, its temporary quarters. The permanent medical school buildings will be a part of University City on Mt. Scopus and nearly $4,000,000 of the $5,500,000 needed for their completion has been raised. The first class will be comprised of 50 students, selected from 200 candidates whose previous medical training had been interrupted by military service. By 1951 classes will receive the full six-year instruction course. Graduates will receive M.D. degrees. Members of the medical faculty include B. Zondek, gynecology; A. Feigenbaum, ophthalmology; S. E. Franco, pathological anatomy; Saul Adler, parasitology; and L. Olitzki, bacteriology. One of the first visiting professors from the U. S. will be Samuel Standard, associate professor of clinical surgery, New York University College of Medicine—Bellevue Medical Center, who will inaugurate surgical instruction at the school.

The University of North Carolina opened its new Morehead Building and Planetarium at Chapel Hill on May 10. The $3,000,000 building, a gift of John Motley Morehead, houses the Zeiss planetarium instrument with its 250 projectors, as well as exhibits in astronomy and allied sciences, and a permanent collection of famous paintings. Roy Kenneth Marshall, former director of the Fels Planetarium in Philadelphia, has been appointed director.

Meetings and Elections

AAPA meeting in Philadelphia. The 18th annual session of the American Association of Physical Anthropologists was held April 11–13 in Philadelphia, at the Wistar Institute of Anatomy and Biology.

Somatotype distributions (types of body build) found within a Japanese population were presented, and the usefulness of such distributions in racial taxonomy was reaffirmed. Results of a study confirming Sheldon's posture-physique relationships were discussed, and a possible physique-metabolism-disease interrelationship in coronary artery disease was reported.

Researches in anthropomorphometric problems have determined the measurements most diagnostic for somatotyping and, a new technique, stereophotography, have developed as a solution to the problem of standardizing morphological observations. Several newly designed anthropometric instruments were demonstrated.

Papers in racial prehistory included the presentation of new data confirming Hrdlicka's scheme of population succession in the Aleutian Islands. Reexamination of the Galley Hill site and of the original finds have shed new light on the long-disputed antiquity of Galley Hill Man; new evidence suggests that the finds are Holocene in date. The Swanscombe site has also been reexamined and the antiquity of Swanscomb Man reaffirmed.

On Wednesday and Thursday, the AAPA held a joint meeting with the American Association of Anatomists at Temple University. The Wednesday papers were of general interest; topics covered were research in growth, problems in human evolution, and the significance of the various blood grouping factors in defining the varieties of mankind. On Thursday, a symposium organized by F. Gaynor Evans was held on human anatomy and biomechanics.

The annual banquet was held Tuesday evening. Guests included Paul Fejos, director of The Viking Fund, Inc., and Adolph Schultz, the 1948 recipient of the Annual Viking Fund Medal and Prize in Physical Anthropology. On behalf of the association, Dr. Stewart expressed gratitude to Dr. Fejos for the support and encouragement the Viking Fund has given to research in physical anthropology. S. L. Washburn was the speaker of the evening. In his paper, "Three Stages in Human Evolution," he discussed the differential rates of evolution manifested by the several regions of the primate body. He suggested three areas—trunk and upper limbs, lower limbs, skull and brain—as constituting three different unit-areas of change, and as representing three stages of evolutionary change.

At the business meeting of the session T. D. Stewart was elected president, succeeding W. M. Krogman; L. Angel and J. Birdsell were elected to the executive committee; and S. L. Washburn was appointed an associate editor of the *Journal*.

RUTH A. MARZANO
Hunter College

At the meeting of the **Eastern Psychological Association** held April 8 and 9, at the Hotel Kimball in Springfield, Massachusetts, the following officers were elected: president, 1949–50, Hadley Cantril, Department of Psychology, Princeton University; directors, 1949–50, Richard S. Crutchfield, Department of Psychology, Swarthmore College, to complete the term of a resigned member; 1949–52, Carl I. Hovland, Department of Psychology, Yale University, and Francis W. Irwin, Department of Psychology, University of Pennsylvania; secretary, 1949–52, Charles N. Cofer, Department of Psychology, University of Maryland.

The Association of Geology Teachers elected the following officers at its annual meeting at the University of Chicago, April 22–23; president, C. L. Bieber, De Pauw University; vice president, Paul R. Shaffer, University of Illinois; secretary-treasurer, Katherine F. Greacen, Milwaukee-Downer College; and editor, Percival Robertson, Principia College.

The election list of the National Academy of Sciences, published in *Science* last week, should have included a seventh foreign associate, Hideki Yukawa, of the Institute for Advanced Study.

The American Institute of Nutrition, at the Detroit meeting of the Federation of American Societies for Experimental Biology, April 18–22, elected the following officers: president, C. G. King, scientific director, Nutrition Foundation, Inc.; vice president, W. H. Griffith, professor of biochemistry and nutrition, University of Texas Medical School; secretary, J. H. Roe, professor of biochemistry, George Washington University Medical School; treasurer, N. R. Ellis, assistant chief, Animal Husbandry Division, United

States Department of Agriculture; and councilor, Arthur H. Smith, professor of physiological chemistry, Wayne University College of Medicine.

Industrial Laboratories

Sharp and Dohme, Inc., of Philadelphia, will begin construction of its $4,000,000 Medical Research Laboratories at West Point, Pennsylvania this fall. The laboratories, which are expected to be ready for occupancy early in 1951, will house research departments in organic chemistry, pharmaceutical chemistry, biochemistry, immunochemistry, pharmacology, bacteriology, nutrition, virology, and antibiotics. Space has also been provided for a proposed department of biophysics to be organized next year.

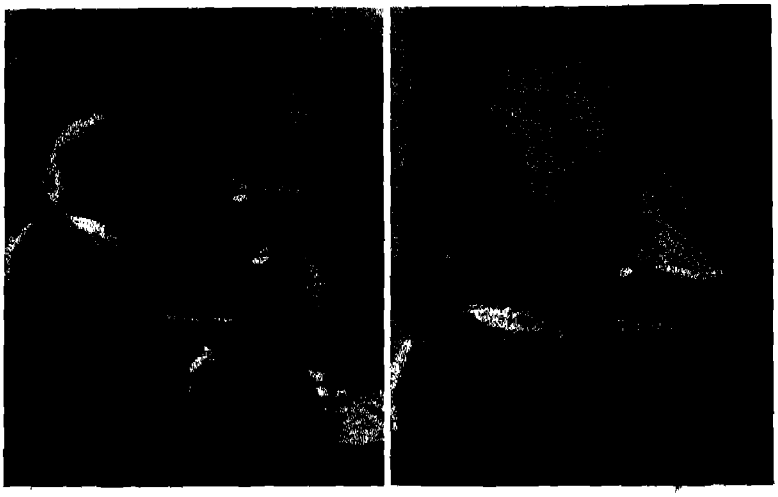
The Elliott Company, of Jeannette, Pennsylvania, manufacturer of power plant equipment, has developed a new process for the manufacture of tonnage oxygen, as reported by Irving Roberts of the company's Research and Development Branch, at the American Institute of Chemical Engineers' Tulsa meeting last week. The process consists of partially drying the air at a pressure slightly above atmospheric, then removing the moisture, carbon dioxide, and acetylene in a heat exchanger which simultaneously cools the air to 318° below zero. The air is then fed to a fractionation column from which the oxygen is withdrawn as a gas from the bottom, and nitrogen is withdrawn as a gas at the top. The advantages over former processes lie in eliminating the explosion hazard and the necessity for periodic shutdowns to thaw out the plant.

Shipments from the Arnhem Land Expedition—400 birds, 800 marsupials, 10,000 fish, and several hundred anthropological specimens—arrived early this month at the Smithsonian Institution, where they are being cleaned and catalogued. They were collected by a team of 15 American and Australian scientists who explored the swamps, dense forests, and coast of the Australian hinterland from March to December last year, on an expedition sponsored jointly by the National Geographic Society, the Smithsonian Institution, and the Commonwealth of Australia (see *Science*, 107, 190; 109, 182). Thirteen thousand botanical specimens were left behind to be classified in Australia before final distribution.

Ornithologists made the first record in Australia of a cattle egret or buff-necked heron—a bird previously found in Asia, Africa and South America; archaeologists excavated early Malay sites (around the 15th and 16th centuries); and anthropologists made 250 palm- and finger-prints of the natives, for possible genetic studies. The expedition made five miles of color film of the country, thousands of photographs of the natives, and wire recordings of their speech and ceremonial dances.

Kulpija (see photographs) was bat boy for the expedition. One of the more intelligent natives and an excellent worker and artist, he helped with the archaeological work and acted as guide and informant, speaking a pidgin English. Frank M. Setzler, Smithsonian curator of anthropology, made facial masks of many natives, using a putty-like material that pulls loose easily from hairs on the face or head. He heated it in a double boiler over an open campfire, let it cool to a comfortable temperature, and smeared it over the native's face. When the mold hardened he pulled it off and poured in plaster of Paris, to make the cast.

All members of the expedition, according to Dr. Setzler, were on even better terms after eight months of continuous tent life in the bush than they were when they set out—a fact that he feels has hopeful implications for international relations.



—Photos by Howell Walker, National Geographic Society

UMBAKUMBA, GROOTE EYLANDT: On this remote Australian island, Anthropologist Frank M. Setzler makes a facial mask of Kulpija, one of the natives studied by the Arnhem Land Expedition. Masks like these will be used in making life-sized exhibition groups of Australian aborigines.

Laboratories — academic, governmental, or institutional — having new and outstanding 16-mm scientific motion pictures (with or without sound) may arrange showings of their films at the annual meeting of the AAAS, New York City, December 26–31, by writing to:

Science Theatre, AAAS,
1515 Massachusetts Ave., N. W.
Washington 5, D. C.

The Seventh Pacific Science Congress

Knowles A. Ryerson[1]

University of California, Davis

THE SEVENTH PACIFIC SCIENCE CONGRESS convened in Auckland and Christchurch, New Zealand, February 2 to March 2, 1949, marking a resumption of these important gatherings after an interruption of ten years occasioned by the war. Two hundred twenty overseas delegates from 16 countries and their colonies and dependencies and a New Zealand registration of more than 400 made up the attendance.

The congress met in a world marked by the impact of war, a world shrunk by shortening communication and transportation lines. Its theme, drawn from the terrible destruction of human and material resources, and the compelling necessity to meet the increasing demands of an industrialized age, was conservation on an international scale. The human race is in sight of the end of many of its usable resources, and must take stock and plan their intelligent use for the benefit of all mankind. For the first time in these congresses, problems of food supply and world population received more than passing comment. The problems of the Pacific are those of the world.

In 1939, when the Sixth Congress was held, war was just beginning in Europe. The mood of the Seventh Congress, meeting when the war was over but the peace was still far from settled, was vastly different. The necessity of cooperative teamwork by scientists of all nations, and recognition of their joint responsibility for building up a society in which men the world over might live in freedom, colored the many joint symposia. The world race against ignorance, limited food resources, and increasing world population was stressed again and again. It was expressed concretely in terms of the urgent necessity for intelligent use of sea and soil, for public health measures, and for extension of the social sciences.

The Congress opened with a plenary session, at which reports were made by eleven standing committees: *Oceanography, Protection of Nature, Volcanology, Soil Survey and Classification, Mountain Structure, Classification and Utilization of Land, Forestry, Economic Entomology, Blood Groups, Seismology,* and *The Distribution of Terrestrial Faunas in the Inner Pacific.* Following the plenary session nine divisions initiated their several programs: *Anthropology; Botany; Geology, Volcanology and Geophysics; Meteorology; Oceanography; Public Health and Nutrition; Social Sciences; Soil Resources, Forestry and Agriculture;* and *Zoology.* A special division on *Organization of Research* was set up to consider and coordinate research proposals and projects recommended by each of the nine divisions.

The interdependence of the different scientific disciplines was emphasized by the sixty-odd symposia, and the many informal joint discussions on common problems. This interrelationship is well illustrated by the problems of mutual responsibility for dependent peoples in the Pacific area; anthropology, agriculture, public health and nutrition, and social sciences were all involved in considering satisfactory solutions to the problem of the island native in a rapidly changing world. The importance of international weather services to agriculture, transportation (both surface and air) and general human welfare, and means for implementing such needed objectives formed an active area of discussion.

The problem of insect pests and diseases spread by the airplane—the great harm to agriculture and the even greater threat of human disease—brought together specialists in entomology, botany, agriculture, public health, social sciences and anthropology.

Organization of research to meet the challenge of a changing world received the serious consideration of every division and resulted in a series of strong recommendations at the final plenary session for a concrete program, outlining specific projects to be initiated.

It was recognized that any effective program presupposed a permanent secretariat organization to function between sessions of the congress in aiding the standing committees. Accordingly the council approved a change in the constitution of the Pacific Science Association providing for a minimum secretariat if and when funds permit and competent personnel can be secured.

Trained personnel was also recognized as a basic necessity in carrying out any research program. The exchange of qualified students and staff members, as a powerful aid in this direction, was a subject considered by several of the sections. The Fulbright program for the exchange of scholars was discussed in relation to those Pacific countries party to it. The officer attached to the U. S. Embassy and charged with Fulbright matters arrived in New Zealand during the congress and contributed much to the clarification of the program and its relation to Pacific research.

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[1] Chairman, Pacific Science Board, National Research Council, and head of the U. S. Delegation to the Seventh Pacific Science Congress.

The social implications of science and their application to a rapidly developing world were recognized in the devoting of an entire session of the division of social science to this subject. There was also a panel discussion of the topic by a group of delegates at an evening public meeting. Recognition of the social effects of scientific discovery served as a common uniting thread running through the sectional sessions. The basic relationship of science to human progress and civilization was a constantly recurring theme.

More than 500 papers were presented during the congress. They covered a wide range, from the beginning discussion in anthropology on "The Native Reaction to an Invading Culture and Its Bearers" to the closing discussion in zoology, on "Factors Influencing the Fresh Water Development or Production of Salmon." Pending publication of the full proceedings, a few brief paragraphs may serve to summarize the deliberations of the several divisions.

Anthropology. The discussions in the section centered around the general topic of administration and welfare, including contemporary cultural changes among Pacific peoples. These considerations involved studies of the spread of peoples and cultures and included the problems of Indonesia and Australia. Much material was drawn from surveys made during and since the war in the Japanese mandated territory, and the coordinated Micronesian project carried out by the Pacific Science Board of the National Research Council. The presence of Sir Peter Buck at the Congress, and his active participation in the discussions, added much to the vividness of the program.

The problems of anthropology are inseparable from those of public health and nutrition, agriculture, and social science, as well as those of the specific science groups. Symposia in which the several sections participated were especially fruitful in clarifying the interrelated human problems facing government agencies responsible for governing dependent peoples.

Among the studies recommended jointly by this section and that of social sciences were ethnographical studies in those areas wherein detailed information is lacking. Pilot studies of the process of social and cultural change, and population studies and their relation to land, education, and economic future were especially urged.

Botany. In the botanical program major emphasis was placed on morphology, taxonomy, and distribution of Pacific marine algae, including vertical distribution with relation to the tidal factor. The industrial and agricultural utilization of marine algae also received considerable attention. Of outstanding interest was a joint program of botany and zoology considering protection of nature and conservation in the Pacific.

Research in plant ecology and vegetation science aimed at solving problems of conservation of natural resources, of rare and scientifically interesting species, and of vegetation types, was strongly recommended. More botanical exploration was also urged, to fill in the gaps of the Pacific flora still imperfectly known.

Geology, Volcanology, Geophysics. With the congress meeting in an area of peculiar geologic interest which could be drawn upon for much concrete illustration, a wide range of topics were considered. The mineral resources of the Pacific, the geological history of the Pacific basin, seismology emphasized through local demonstrations by an obliging nature, and terrestrial magnetism were emphasized. There were a number of discussions on cosmic relationships, radiophysics, and the physics of the upper atmosphere, involving auroral studies and cosmic rays. Interest reached well out beyond the earth in the discussion of recent investigations of radiofrequency radiation from both sun and moon, radio echoes from meteors, and observations on galactic noise. The discussions on volcanology were highlighted by a convenient, full dress, violent eruption of the volcano *Nguaruhoe* during the field trip of the North Island. Among the important recommendations from this section were those for additional seismological stations to be set up in the Pacific, to fill in gaps now handicapping uniform investigations. A bore hole 16,000 feet deep at Bikini was recommended to establish stratigraphical and paleontological sequences, to aid in the interpretation of geophysical records, and to furnish observations on temperature and related problems.

Meteorology. The discussion of this section reflected the marked developments of the war years, especially in the Pacific, in emphasizing the need for adequate reconnaissance forecasting of rainfall, hurricanes, and typhoons. A strong recommendation for a more adequate network of meteorological stations in the Pacific was made. The importance of a complete upper air meteorological section from pole to pole (from the North Pole through Alaska, the Pacific Islands, and New Zealand to Antarctica) was stressed, in order that adequate data on the problem of general air circulation would be available.

Oceanography. The oceanographic program provided the first opportunity to discuss the immense amount of oceanographic data accumulated during the war. Particular attention was given to the development and application of the new instruments—of which the Bathy-Thermograph is an outstanding example—for speeding up oceanographic investigations. It was pointed out that in spite of the great mass of data already available there are still immense areas of the ocean, especially outside the regular shipping lanes, that need to be explored. It was urged that these be investigated as soon as possible, using the modern facilities and techniques now available.

The sessions also heard reports on the activities and plans of marine laboratories in the Pacific, together with preliminary results of the Swedish Deep Sea Expedition and plans for the Danish Oceanographic Expedition in the South Pacific.

One of the very gratifying features of this congress was the emphasis placed on the interrelationship of physical and chemical oceanography with meteorology, geology, and fisheries. A number of joint sessions were held at which members of two or more sections pooled their specialized knowledge to the advantage of all. These were especially noteworthy in connection with discussions on "The Harvest of the Sea," the conservation of fisheries and whaleries, with all their national and international implications.

Public Health and Nutrition. Because of their direct bearing on the welfare and the continued progress of all the peoples of the Pacific, primitive and more advanced, the discussions of this section were especially significant. The war had provided new knowledge and experience in regard to a number of the important diseases—especially filariasis, leprosy, leptospirosis, malaria, schistosomiasis, and related diseases. These diseases and the general problems of nutrition and dental caries received excellent and critical appraisal. As an outgrowth of these discussions an urgent recommendation was made that a Pacific epidemiological center for the correlation of information on diseases be established. Systematic food analyses of native foods, using modern techniques, were recommended, along with surveys of diet and food habits. Surveys of disease-carrying insects, fungi, and viruses were also recommended.

The joint session with the sections on anthropology, agriculture, and the social sciences, in which health and nutrition problems of dependent peoples, the changing agriculture, and the special problems of mixed bloods and their relation to administration were all thoroughly considered, was among the most significant discussions of the entire congress.

Social Sciences. As has already been indicated, much of the program of the social science section was carried out in conjunction with the sections on anthropology, agriculture and public health. These discussions centered around administration and welfare, and included consideration of contemporary culture changes of Pacific dependent peoples. The economic and power resources of the Pacific were reviewed in relationship to future developments of the area and their impact on dependent peoples. Wide variation in language and dialect has imposed special problems in education. Mass media of communication among dependent Pacific peoples and their relation to education were the subject of an important group of discussions in the section.

The social implications of science, so much in the forefront of the world's thinking today, were presented in a series of papers at a half-day session of this section. In addition a panel discussion, participated in by five speakers representing different disciplines, was presented as one of the evening public programs.

In cooperation with anthropology, this section strongly recommended the principle of team research in meeting the social, economic, and health problems of Pacific peoples, and indicated specific areas where these team research programs should be undertaken. A proposal for making such a coordinated attack in Samoa was recommended.

Soil Resources and Agriculture. In these sessions there was extensive discussion leading to recommendations on methods and techniques for soil classification and mapping, and their relation to land use. As a basis for planning economic development, an early estimate of soils in the Pacific usable for agricultural and forestry purposes was urged. Conservation of soil was to a large extent included in the general discussion of conservation and the protection of nature. Field trips emphasized the importance of conservation measures in relation to local agriculture. Special air and field reconnaissance studies were carried out by visiting scientists at the request of New Zealand officials, in order to make good use of the experience of Canadian and U. S. specialists in this field.

Under the general heading of "Improvement of Agricultural Production in the Pacific Area," both livestock and field crop production were considered. The importance of introducing and maintaining high grade genetic stocks was stressed, and the extensively developed pasture system of New Zealand, with its high productivity on a sustained basis, was especially studied from both the animal and plant point of view. In addition to the special papers in this section, joint symposia with anthropology and social sciences and zoology also considered agricultural deevlopment, as has already been indicated. The urgent problem of insect pest and disease surveys was given special consideration and execution of the surveys was urged at an early date in order to determine what potential hazards are present in unexplored islands. Plant diseases, especially virus infections, and insects and other vectors at work in the Pacific were examined.

Forestry. Under the general heading of "Forestry Problems of the Pacific" a comprehensive series of papers outlined the complex picture of forestry in this area, especially in tropical latitudes. The application of tree selection was well exemplified in local New Zealand practice. C. S. Larsen of Denmark, a world authority on tree breeding, and M. Maurice Leloup of France, director of the forestry subdivision of the Food and Agricultural Organization, added breadth and depth to the discussion. In the joint symposia on protection of nature, the vital place forestry held was strongly emphasized. The need for preserving native species in stand areas before these species became extinct was strongly stressed. More fundamental research in the fields of ecology and plant physiology was urged, particularly studies relating to silviculture requirements and management practices. Field trips in the different New Zealand forest areas were used for graphic demonstrations of problems under discussion. New Zealand presents an excellent example of exotic trees' spreading and replacing native species, largely podocarps, in timber production. Representatives of timber buyers, saw milling firms, timber growers' associations, and forest tree seed producers also attended the conferences so that theoretical and practical considerations were blended in the program.

Zoology. Because of the number of papers submitted and the extent of the fields involved, this section divided into subdivisions on zoology and economic entomology. The discussions of the zoologists centered about distribution, biogeographical provinces, whaling, and fisheries. The importance of fisheries in the economic life and food supply of Pacific peoples was thoroughly discussed in its many aspects.

The entomologists concerned themselves primarily with means for preventing further dissemination of pests dangerous to the agriculture of the Pacific area. The high light of the conference was a symposium on biological control of weeds, probably the first ever held. Australia and New Zealand have pioneered this method of attack, and Hawaii and Fiji have also achieved valuable results. In California the biological control of St.-John's-wort (*Hypericum perforatum* L.) is now developing in a most promising way. Intensified surveys on insect pests and diseases of agricultural crops, designed to increase protection against their spread, were recommended.

Much of the general discussion of the section was devoted to the problem of conservation and protection of nature, in cooperation with other sections of the congress. A sense of urgency was felt—time is running out while vestiges of many island species of animal and plant life disappear.

Organization of Research. The special division set up under the chairmanship of R. S. Allan,[2] for the study of the organization of research, brought together the recommendations from each of the other divisions, correlated them, and presented them for discussion and adoption at a closing plenary session. Some of the recommendations in specific fields have already been mentioned. Attention was also given to the need for improved training of young scientists and better working facilities for trained scientists, for more recognition and adequate support for museums and collections as research aids. A strong recommendation urged that expeditions provide for the preparation and preservation of their collections. Strong emphasis was placed on the use of teams of scientists for best results in projects involving social problems in which several related disciplines are concerned.

Special mention should be made of the varied and exceptionally well-organized intersession and postsession field trips which so thoroughly supplemented the discussion of the sections. For the overseas delegates they made possible seeing in a relatively short time the outstanding features of New Zealand's unusual flora and fauna, its spectacular volcanic and thermal regions, mountains, and glaciers, its highly developed agriculture, and the progress of its Maori people and their integration with the national life of New Zealand.

The far-reaching implications of the congress were evidenced by the presence of a representative of Unesco, Ging Tsi Wang, three representatives of the Food and Agricultural Organization, and four observers from the Research Council of the South Pacific Commission. The largest overseas delegation was from the United States,[3] and was comprised of 65 members; of these 41 were from the mainland, 11 from Hawaii (including U. S. government scientists based there), 4 from the Trust Territory, and 9 from Japan (4 from SCAP, 4 from the U. S. Air Force Airweather Service, and 1 from the U. S. Fisheries program in the

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[2] Professor of geology, Canterbury College, and chairman of the Christchurch committee for the congress.

[3] For organization of the U. S. delegation and its transportation by air to and from New Zealand, principal thanks are due to Harold J. Coolidge, executive secretary of the Pacific Science Board of the National Research Council, whose energy and good humor made for an effective U. S. representation.

Philippines). The delegates represented 11 universities, 5 museums and institutions, and 12 U. S. government civil and military organizations. The 25 delegates of the National Research Council and delegates from 15 other organizations, including the armed forces and civilian scientists, were provided air transport from the mainland of the U. S., Hawaii, and Japan. A widely representative delegation was thus made possible through the effective cooperation of the Military Air Transport Command and the Air Weather Wing of Japan.

On the way down to the Congress a group of U. S. delegates spent a memorable 24 hours at American Samoa on the invitation of the Governor, Captain Vernon Huber, U.S.N. They were received with great hospitality and had an excellent opportunity to look over the various activities of this American outpost in the South Pacific as well as to discuss local scientific problems with the administrative officials and scientists working there.

On the return trip, at the official invitation of the French Government, 27 U. S. delegates made a 24-hour visit to Noumea as guests of the Territory of New Caledonia and the *Institut Francais d' Oceanie*. The American group was officially received by the Governor-General and had an opportunity to visit the various laboratories of the *Institut,* which occupy the buildings of a former U. S. Naval Hospital, and to make brief but interesting field trips accompanied by various members of the *Institut* staff. The Secretary-General of the South Pacific Commission welcomed the delegates at his new headquarters located in the former U. S. Army building ,which was widely known during the Pacific War as the "Little Pentagon." The hospitality extended by everyone in the New Caledonia visit was in the best French tradition, and will be long and gratefully remembered.

Admiral D. C. Ramsey, Commander in Chief of the U. S. Navy in the Pacific and High Commissioner for the Trust Territory, arranged for a special flight for the U. S. geologists from Honolulu to the island of Hawaii to study volcanic activities. F. G. Oberhansley, superintendent of the Hawaiian National Park and the delegate of the National Park Service to the Congress in New Zealand, arranged the ground tour to "Volcano House." The trip added one more special opportunity to enlarge field experience and was especially appreciated.

For the splendid organization of the congress, all credit is due its officers—the president, R. A. Falla; the secretary-general (and chairman of the Auckland committee), Gilbert Archey; the chairman of the Christchurch committee, R. S. Allan; the treasurer, S. Cory Wright; the secretariat assistants, and their associates on the committees. Herbert E. Gregory, U. S. member of the Pacific Science Council, was an honorary vice president—a well-deserved recognition of his veteran service in the congresses. The task of the officers was especially difficult because of the lapse of ten years between congresses, the lack of any adequate continuing secretariat, and the great distances involved.

The congress gave special praise to the press and radio for the uniform excellence of their reporting service, which was thorough, accurate, balanced, and understanding.

The warmhearted, generous hospitality everywhere at hand surrounded the sessions with a friendly atmosphere that captured all.

The Royal Society of New Zealand and through it, the government and the people of New Zealand have reinstituted again the Pacific Science Congress, as an effective agency in scientific endeavor in the Pacific area. They have set a high standard for future congresses.

Evidence for the Occurrence of Nor-Epinephrine in the Adrenal Medulla[1]

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NOR-EPINEPHRINE (nor-adrenaline, arterenol) is a primary amine differing from epinephrine only by the absence of an N-methyl group. Its presence in the mammalian body was first demonstrated by pharamacological methods (*9*): extracts of postganglionic adrenergic nerves of cattle showed an activity corresponding to 10–15 μg of L-nor-epinephrine per g of tissue. Its functional importance as sympathin E had previously been suggested by Bacq (*1*) and as a possible precursor of epinephrine by Blaschko (*2*).

Studies on the hemodynamics of epinephrine and nor-epinephrine and its possible relation to the problem of hypertension (*4*) have raised the question as to whether nor-epinephrine is present in the normal adrenal medulla and in tumors of chromaffin tissue (pheochromocytomas).

Since bio-assay of small amounts of nor-epinephrine in mixtures containing large quantities of epinephrine did not seem feasible, chemical methods were used to show the presence of nor-epinephrine in extracts of the adrenal medulla of cattle (U.S.P. epinephrine and U.S.P. epinephrine reference standard). Synthetic epinephrine and nor-epinephrine (Winthrop) were used as standards in these experiments. It was found that the extracts of adrenal medulla contained considerable amounts of nor-epinephrine.

The method employed for the identification and quantitative estimation was chromatography on filter paper, similar to the procedure of James (*6*). Phenol (saturated with water) in an atmosphere of HCl was found to be the most satisfactory solvent and the addition of 8-hydroxyquinoline was found advantageous to avoid tailing. The filter paper used was Schleicher and Schuell No. 597, Whatman No. 1, or Eimer and Amend No. 9–930. All gave satisfactory results. The chromatograms were run for 16–18 hours, in an upward direction (*10*) with the solvent at the bottom of the jar. The substances to be studied were dissolved in acidic alcohol (1 ml conc. HCl per 100 ml 95 percent ethanol) and 0.01 ml applied to the paper. The alcoholic solutions give smaller and better defined spots than aqueous solutions. The spots were developed with 0.44-percent potassium ferricyanide-solution (pH 7.8) according to James (*6*). This leads to the formation of the corresponding adrenochromes (quinones). The colored spots thus produced afforded a better contrast, especially for quantitative estimations, when the paper was subsequently sprayed with a ferric sulfate solution[3] which converted the ferrous salt into Prussian blue. Chromatograms treated in this way are, however, not stable; they gradually turn diffusely blue. In both procedures, the papers were dried and developed at room temperature without heating. Amounts of epinephrine and nor-epinephrine as low as 2 μg could easily be demonstrated.

The colors of the spots obtained by ferricyanide spraying and by spraying with ninhydrin solution (*8*) were useful in distinguishing the spots obtained with nor-epinephrine and epinephrine from those given by Dopa and hydroxytyramine respectively, since the chromatographic demonstration of the latter substances is difficult in the presence of epinephrine and nor-epinephrine. The colors given by these substances are listed in Table 1. Neither Dopa nor hydroxytyramine was found in any of the epinephrine preparations or tumor extracts studied.

TABLE 1

	R_f values*	Color of the spots after spraying with :	
		Ferricyanide	Ninhydrin
Epinephrine	0.50–0.55	pink→yellow	violet
Nor-epinephrine .	0.27–0.33	lavender→brown	mustard
Dopa	0.35–0.38	yellow-pink→blue	dark blue
Hydroxytyramine	0.45–0.50	lavender	mustard

* The R_f values are subject to considerable variations, depending upon conditions.

A quantitative estimation of epinephrine and nor-epinephrine was feasible by planimetry and semilogarithmic calculation (*3*) of the Prussian blue spots. Extracts of the adrenal medulla of cattle (U.S.P. epinephrine) were found to contain 12 to 18 percent nor-epinephrine; a single sample contained as much as 36 percent, as can be seen in Table 2 (Exp. 2).

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[1] This work was supported in part by a grant from the Albert & Mary Lasker Foundation.

[2] Life Insurance Medical Research Fund Fellow.

[3] Ferric sulfate anhydrous 5.0 g; phosphoric acid 85 percent, 75 ml; water to 1000 ml. We are grateful to Dr. Boris Magasanik for suggesting this procedure.

The epinephrine fractions from three chromaffin tissue tumors were found to contain 50 to 90 percent nor-epinephrine. Similar findings in adrenal medullary tumors have recently been reported by Holton (*5*).

The hormone of the adrenal medulla thus corresponds in its dual nature to the two known sympathetic mediators: epinephrine and nor-epinephrine. This is of particular interest, since epinephrine and nor-epinephrine differ significantly in their pharmacological actions. Recent hemodynamic studies in man using the method of right heart catherization (*4*) have shown that epinephrine within a physiological range acts as an over-all vasodilator and causes hypertension only by increase of cardiac output. Nor-epinephrine, on the other hand, acts as over-all vasoconstrictor with no change or slight decrease of cardiac output. These two agents also differ in their metabolic effects; e.g., the hyperglycemic action of nor-epinephrine is much less marked than that of epinephrine (ratio 1:8) (*7*). If one assumes that natural epinephrine, as secreted by the adrenal gland, constantly maintains a content of, let us say, 18 percent nor-epinephrine, our present concepts of adrenal secretion are fully valid, since small constant quantities of nor-epinephrine would not significantly alter the functions of epinephrine. The hemodynamic studies quoted above (*4*) were done with extracted epinephrine (U.S.P. epinephrine) and brought out fully the differences between epinephrine and nor-epinephrine and their antagonism. But if one assumes that under varying physiological conditions the nor-epinephrine content of the secreted natural epinephrine varies, current views of the physiology of the adrenal medulla may have to be modified.

TABLE 2

Exp. No.		Epinephrine*	Nor-epinephrine*
		%	%
1	U.S.P. reference standard sample 1	81.5	18.5
2	" " " " 2	64	36
3	" " " " 3	84	16
4	" epinephrine	88	12
5	" "	100	0
6	Pheochromocytoma No. 1	47	53
7	" " 2	12	88
8	" " 3	10	90

* Each value represents at least 5 parallel determinations (concordant within 10%).

There is no doubt that under pathological conditions, e.g., in pheochromocytoma, the nor-epinephrine content of the secreted medullary hormone may increase considerably, since the tumors have been demonstrated to contain up to 90 percent nor-epinephrine. The hemodynamic effects and the influence on carbohydrate metabolism are then profoundly altered.

The tumor extracts were bio-assayed[4]. The proportions of nor-epinephine and epinephrine found were in good agreement with the chemical estimations. The bio-assays were performed by matching the tumor extracts with corresponding mixtures of epinephrine and nor-epinephrine. If the bio-assay is done solely by calculation of the nor-epinephrine content from the responses of nor-epinephrine "insensitive" and "sensitive" test objects, chemical determination and bio-assay do not agree. We think that the error in the bio-assay is due to interference of epinephrine and nor-epinephrine action (competition for equal cell receptors).

In summary, the dual nature of the adrenal medullary hormone has been demonstrated by chromatography on filter paper. Natural epinephrine contains variable amounts of nor-epinephrine.

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[4] We are grateful to Dr. F. P. Luduena for performing the bio-assays.

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The Separation of L-Arterenol from Natural U. S. P. Epinephrine

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RECENTLY GOLDENBERG, *et al.* (*3*) obtained evidence by paper chromatography indicating the presence of appreciable quantities of arterenol in crystalline U.S.P. epinephrine derived from adrenal glands. This information, kindly transmitted to us by Dr. Goldenberg in November 1948, suggested the desirability of attempting physical isolation of the arterenol from such samples.

A review of the literature quickly reveals a body of physiological information which can be interpreted to indicate that chromaffin tissue, which constitutes the medulla of the adrenal gland and is the source of natural etinephrine, may elaborate more than one hormone having etinephrine-like properties. In fact, Gaddum and Goodwin (*2*) have confirmed earlier suggestions that the substance released by stimulation of the hepatic nerves of cats may be arterenol. However, direct chemical evidence to support the physiological observations have been lacking, and indeed, only recently have the chemical properties of L-arterenol become known (*4*).

We now wish to report the isolation of pure L-arterenol from several commercial lots of natural epinephrine and also from a sample obtained from the bulk stock of U.S.P. epinephrine reference standard through the kindness of the U.S.P. Board of Trustees.

A 10-g sample of natural U.S.P. epinephrine, containing 17–18 percent arterenol by analysis (*1*) was dissolved by stirring with 8.5 g D-tartaric acid in 75 ml of methanol and 2 ml of water at 25°. When the solution was seeded with L-epinephrine D-bitartrate and let stand overnight a heavy crop of crystals separated. This was collected, washed with a little methanol, and dried *in vacuo,* yielding 15.1 g of L-epinephrine D-bitartrate, mp 147–149°. Analysis of this fraction indicated the presence of about 6 percent arterenol bitartrate.

The methanol liquor and wash were concentrated *in vacuo* at 25–30° and the residue was dissolved in 10 ml water containing 0.2 g $NaHSO_3$. Ammonium hydroxide was added until a faint ammonia odor persisted and the resulting slurry of base was kept at 5° one hour. The precipitated base was collected, washed with a little water, and dried *in vacuo.* There was obtained 1.56 g (mp 190–193° with decomposition), or a total recovery of 98 percent.

TABLE 1

COMPARISON OF NATURAL AND SYNTHETIC L-ARTERENOL*

	Mp °C (corrected)	Mixed mp °C (corrected)	$[\alpha]_D^{25°}$	Analyses		
				% N	% C	% H
L-Arterenol L-bitartrate			Calculated	4.40	45.20	5.33
Natural	163–4	162–3	−40.2	4.37	45.30	5.38
Synthetic	163.5–164.5		−39.6	4.60	45.47	5.58
L-Arterenol D-bitartrate						
Monohydrate			Calculated	4.15	42.73	5.65
Natural	101–102	101–102	−12	3.99	42.86	5.86
Synthetic	102–104		−11		Ref. 2	
L-Arterenol hydrochloride			Calculated	6.80	46.72	5.88
Natural	147.5–148.5	145.6–147	−39.8	7.01	46.83	5.76
Synthetic	146–147		−40		Ref. 2	

This base (1.42 g) was dissolved with 1.25 g L-tartaric acid in 11 ml methanol containing 0.3 ml water. The solution was seeded with L-arterenol L-bitartrate and let stand at 5° overnight. The crystalline precipitate was collected, washed with a little cold methanol, and dried *in vacuo* to give 0.7 g, mp 157–159°. Analysis indicated 95 percent arterenol bitartrate. Recrystallization from 90-percent methanol yielded 0.25 g having mp 161–3°.

Similarly an 80-g sample from the same lot of natural epinephrine gave 7.7 g of once-crystallized L-bitartrate mp 157–159°. When this was dissolved in 7 ml water and 15 ml methanol by warming to 40–50°, and the solution diluted with 80 ml of methanol, crystallization started promptly. After 20 hours at 5° the precipitate was collected, washed with a little cold methanol, and dried *in vacuo*, giving 3.3 g mp 161–3°. After one more crystallization from 30 ml of 90-percent methanol, 2.8 g of pure L-arterenol L-bitartrate, mp 163–4°, was obtained. An additional recrystallization of a portion did not change the melting point. By reworking the liquors, 1.2 g of L-bitartrate, mp 163–4°, was recovered, making a total equivalent to 2.5 percent of the epinephrine sample.

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* I am indebted to Mr. M. E. Auerbach of these laboratories for the determinations and analyses in this table, as well as for the arterenol assays mentioned in the text. Mr. Auerbach's method for the determination of arterenol in the presence of epinephrine will be the subject of a separate communication.

Portions of this pure L-bitartrate were converted to the D-bitartrate monohydrate and to the hydrochloride, as described previously for synthetic L-arterenol (*4*). The identity of these salts with the corresponding synthetic L-arterenol salts is shown in the table.

In summary, natural epinephrine contains appreciable quantities of levo-arterenol, as shown by isolation of the latter compound. The adrenal gland therefore contains arterenol as well as epinephrine. The present study is believed to be the first isolation of levo-arterenol in chemically pure form from biological material and is thus the final step of proof in establishing the hormonal nature of this substance.

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The Determination of Arterenol in Epinephrine

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USING A PAPER CHROMATOGRAPHIC TECHNIQUE, Goldenberg, Faber, Alston and Chargaff (*1*) were recently able to demonstrate the presence of arterenol (nor-epinephrine, nor-adrenaline) in supposedly pure crystals (U.S.P. grade) of epinephrine derived from adrenal glands. This most interesting finding prompted investigations which led to the actual isolation of arterenol (*2*) from natural epinephrine, and to the development of a chemical method somewhat more convenient for the assay of arterenol in epinephrine than that offered by paper chromatography. It is the purpose of this note to describe the method, and to report the values found for several lots of natural epinephrine.

Reagents. (1) Buffer, pH 9.6 (Clark and Lubs) 50 cc of a solution which is M/5 in both H_3BO_3 and KCl, plus 36.85 cc M/5 NaOH, diluted to 200 cc. (2) Five-tenths percent sodium β-naphthoquinone-4-sulfonate (Eastman Kodak) in water. This reagent must be used before it is one hour old. (3) One percent aqueous solution of alkyl dimethylbenzylammonium chlorides (Roccal or Zephiran) (benzalkonium chloride). (4) Mixed solvent. Eighty-five volumes C.P. toluene plus 15 volumes redistilled ethylene dichloride. Mix only enough for one day's use. Wash the mixture with a little of the borate buffer, then filter through dry paper to remove droplets of water. (5) Epinephrine control solution. One hundred mg pure synthetic epinephrine base dissolved in 2.5 cc of 5 percent aqueous solution of sodium borate, and diluted to 100 cc with water. (6) Arterenol standard solution. Forty mg of pure arterenol base (or its equivalent of the bitartrate) dissolved in 5 cc of 5 percent aqueous solution of sodium borate, and diluted to exactly 200 cc with water. Store in a cold dark place and discard after 24 hours.

Procedure (*setting up the standard curve*). To each of five 50-cc glass-stoppered graduated cylinders, add 1 cc of the control epinephrine solution, and to four of these add respectively 0.25, 0.50, 0.75, and 1.00 cc of the standard arterenol solution. To each cylinder add 1 cc buffer solution, swirl, add 0.5 cc naphthoquinone reagent, swirl; let stand at room temperature for 45 minutes. Add 0.15 cc of the benzalkonium chloride (use of a calibrated dropping bottle is convenient), then add exactly 10 cc of the mixed solvent and shake thoroughly. Let stand for 45 minutes, shaking the mixtures gently at least five times more at regular intervals during this time. After the final shake, the solvent layer (purplish red in the presence of arterenol) should separate clearly. If it is turbid, transfer to a small centrifuge tube, stopper, and centrifuge for a few minutes to clarify. Transfer the extracts to appropriate colorimeter tubes and read the percentage transmittancy in a suitable photoelectric colorimeter, using a green glass filter (540 mμ). Set the instrument to 100 percent transmittancy with the extract from the cylinder containing only epinephrine. When plotted on semilog paper, the values obtained will result in a straight line.

Assay of Epinephrine Crystals. Dissolve a weighed amount of sample in a little 5-percent sodium borate solution and dilute with water, so that the final dilution will be approximately 0.1 percent in borax and will contain about 2 mg epinephrine per cc. Run 0.25-cc, 0.5-cc, 0.75-cc and 1.0-cc portions in exactly the manner already specified, and interpret the final transmittancies by reference to the standard curve. If the content of arterenol is known approximately, there is no need to run a whole series. One sample, estimated to contain 0.1 mg to 0.2 mg arterenol, is sufficient.

Discussion. The absorption spectrum of the colored extract shows a very broad maximum in the area 530 μ–560 mμ.

The borate medium functions not only to maintain a desirable pH level, but also to form a complex with the catechol group and thus diminish chromogenic side reactions. The formation of fatty salts of acidic dyes with long-chained quaternary ammonium compounds has been used very generally in these laboratories as an aid in analytical colorimetry. Some of these salts show a truly impressive hyperchromic and bathochromic effect on being extracted from an aqueous into a nonpolar solvent. Further, by extracting the colored derivative from the original reaction medium, an important degree of selectivity is often achieved. In the present case, the extraction eliminates interference by dihydroxyphenylalanine (dopa) and dihydroxyphenylethylamine (3-hydroxytyramine).

TABLE 1

THE ARTERENOL CONTENT OF EPINEPHRINE FROM NATURAL SOURCES

	Percent arterenol
U.S.P. epinephrine reference standard 1947-1G	17.5
U.S.P. epinephrine reference standard 1949-1H	16.8
U.S.P. epinephrine crystals, Lot No. 73016 ...	18.5
U.S.P. epinephrine crystals, Lot No. 73491 ...	17.0
U.S.P. epinephrine crystals, Lot No. 72354 ...	10.5
U.S.P. epinephrine crystals, Lot No. T-22849 .	10.5

Many of the natural amino acids also yield colored extractives with the proposed assay method. The authors hope to publish elsewhere further details, in connection with experiments now under way on the assay of fresh adrenal glands.

Results. Using the method described, we have examined samples of U.S.P. grade natural epinephrine from several sources. In each case, as shown in Table 1, a considerable amount of arterenol was found.

The authors are indebted to several individuals for help in obtaining representative samples of U.S.P. epinephrine crystals.

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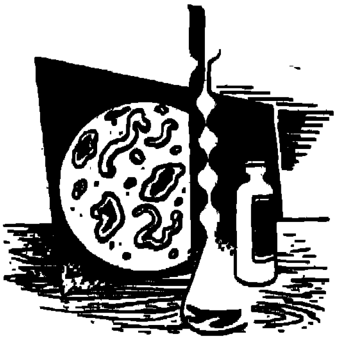

TECHNICAL PAPERS

Inhibition of Estrogen-induced Growth in the Genital Tract of the Female Chick by a Purine Antagonist; Reversal by Adenine

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We have previously reported: (a) that folic acid is required for optimal tissue growth response to estrogen in the genital tract of the female chick and monkey; (b) that several folic acid antagonists quantitatively inhibit estrogen-induced growth in the genital tract of the female chick and rat; and (c) that such inhibition is reversed by the addition of high doses of folic acid (*2, 3, 4*).

The observation of Stokes (*9*) that thymine can replace folic acid as a growth requirement for certain lactobacilli initially suggested that folic acid is involved in purine and pyrimidine metabolism. Accordingly, Hitchings, *et al.* have prepared a number of purine and pyrimidine derivatives which exhibit antifolic acid activity when tested on bacteria. This inhibitory effect is reversible by adenine, i.e., 6-aminopurine, and related compounds (*6, 7*).

TABLE 1

EFFECT OF 2,6-DIAMINOPURINE ON ESTROGEN RESPONSE IN CHICK GENITAL TRACT*

Group	Stilbestrol	2,6-diamino purine (mg)	Adenine sulfate (mg)	Number of chicks	Oviduct weight (mg)
I	–	..	.	10	8 ± 3
II	+	..	..	10	50 ± 5
III	+	15	.	10	14 ± 5
IV	+	10	..	10	22 ± 3
V	+	10	4	10	30 ± 5
VI	+	10	8	10	37 ± 6
VII	+	10	50	8	42 ± 4

* Day-old N. H. red chicks were used; they were given no food but water *ad libitum*; Stilbestrol given at 1 mg daily subcutaneously in 0.2 cc corn oil for 2 days. Other compounds injected at indicated daily dose for 3 days in 1.0 cc aqueous solution or suspension, except for group VII which received adenine by capsule; all chicks were autopsied 24 hr after the last injection.

We wish to report that one of the purine analogues, 2,6-diaminopurine,[1] exerts a marked inhibitory effect upon the estrogen response in the genital tract of the female chick and that this inhibition is largely reversible by adenine, i.e., 6-aminopurine. Table 1 presents a representative experimental series.

It is particularly noteworthy that as much as 5 mg of folic acid does not reverse the inhibition produced by 10 mg of 2,6-diaminopurine (*5*).

In view of our earlier observations concerning the critical role of folic acid in the tissue growth response to estrogens (*2–4*), the present data support the view that folic acid may be concerned with purine and pyrimidine metabolism (*9*).

In any event, it is apparent that folic acid and adenine, and their respective inhibitory analogues, can quantitatively determine the degree of response obtained in a tissue which is under maximal hormonal stimulus for growth. These observations should provide a useful experimental tool for the further study of the basic metabolic mechanisms involved in growth processes in hormone-sensitive tissues.

Moreover, these phenomena may provide a basis for the development of chemical agents of therapeutic value in such clinical states as prostatic and breast cancer, in which a suppression of the biological effectiveness of endogenous steroid hormones has proven beneficial (*1, 8*).

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[1] We are very much indebted to Dr. G. H. Hitchings, Wellcome Research Laboratories, for making this and related compounds available to us; without his generous cooperation these investigations would have been impossible.

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A Capillary-Ascent Test Tube Method for Separating Amino Acids by Filter Paper Chromatography[1]

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Williams and Kirby's (*5*) capillary-ascent modification of the method of Consden *et al.* (*1*) for separating amino acids by filter paper chromatography has been adapted to the separation of less than microgram quantities of amino acids in 6-in. test tubes. It has been shown that amino

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[1] Paper 54. For Paper 53, see Dunn *et al.* (*2*). This work has been aided by a grant from the National Institutes of Health (U. S. Public Health Service).

acids may be separated conveniently, rapidly, and economically by the described procedure.

Strips[2] (13.5 × 1.80 × 1.00 cm) were cut with a paper cutter from Whatman's No. 1 filter paper (14 × 19 cm) with the aid of a line-guide sheet[3] placed over and stapled to the narrow end of the filter paper. It was found convenient to prepare replicate strips by cutting a package of six sheets of filter paper enclosed between two sheets of white wrapping paper. Each packet of six strips was pierced in the center and about 4 mm from the broad end to facilitate suspending the strips during the subsequent drying process. Approximately 500 strips were obtained from six sheets (45.7 × 56.3 cm) of filter paper.

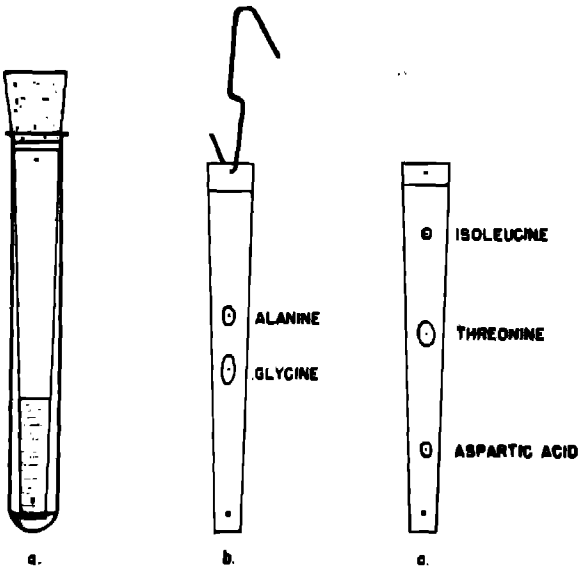

FIG. 1.

The amino acid solution[4] is drawn into a capillary pipet[5] and the tip of the pipet is applied quickly and lightly to the strip at the center and about 6 mm from its narrow end. The wet area, which should not be in excess of 1.5 mm in diameter, is circled and allowed to dry (5 min). Approximately 0.4 ml of water-saturated phenol[6] is pipetted into the bottom of a 6-in. test tube and the narrow end of the amino acid treated strip is inserted into the phenol solution in a position (shown in *Fig. 1.a.*), such that the strip does not touch the walls of the tube except at the upper end. The tube is stoppered with a good quality, rolled No. 9 cork. The tube is allowed to stand for 2 to 3 hr until the solvent ascends to a position about 5 mm below the perforation in the strip. The strip is removed, suspended on a bent paper clip and dried at 110° for about 3 min. The dried strip is sprayed lightly with a 0.25% solution of ninhydrin in water-saturated butanol, and dried at 110° for about 4 min.

The colored spots observed with transmitted light are circled and the center marked. The distances from the center of the original wet area *A* and the final spots *B* and from the former and the solvent boundary *C* are measured. The R_f values are calculated as the ratios, *AB*/*AC*. Tracings of typical chromatograms are shown in b and c of Fig. 1. The R_f values for 17 amino acids (shown in Table 1) compare favorably with those obtained by larger scale, one-dimensional paper chromatography.

TABLE 1

R_f VALUES OF AMINO ACIDS WITH PHENOL

Amino acid	Consden *et al.* (*1*)*	Williams and Kirby (*3*)†	Authors†
Alanine	0.59	0.58	0.62
Arginine	0.62	0.54	0.53‡
Aspartic acid	0.17	0.22	0.25
Glutamic acid	0.28	0.28	0.39
Glycine	0.42	0.36	0.49
Histidine	0.69	0.62	0.81‡
Isoleucine	0.86	0.83	0.85
Leucine	0.88	0.80	0.86
Lysine	0.48	0.41	0.41‡
Methionine	0.81	0.74	0.74
Phenylalanine	0.93	0.83	0.87
Proline	0.86	0.88	0.87
Serine	0.36	0.30	0.38
Threonine	0.50	0.48	0.57
Tryptophan	0.86	0.71	0.81
Tyrosine	0.62	0.55	0.58
Valine	0.77	0.72	0.82

* Descending boundary method.

† Ascending boundary method. Time and distances: 28 hr and 380 mm (*3*); 3 hr and 125 mm at about 25° (authors).

‡ Used as monohydrochloride histidine, monohydrochloride monohydrate.

A rapid, convenient, capillary-ascent test tube method has been described for the separation of less than microgram quantities of amino acids by paper chromatography. R_f values, comparable to literature data, have been determined for 17 amino acids. Numerous samples may be determined simultaneously by the authors' method.

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[2] The filter paper should not be touched with the hands, to avoid amino acid contamination.

[3] Line-guide sheets may be drawn by hand with the aid of a metal template or, more conveniently, they may be printed by means of a stencil which is cut in such a manner that adjacent strips are inverted.

[4] 0.03 *M* solutions have given satisfactory chromatograms of the amino acids investigated.

[5] Prepared by drawing 5-mm pyrex capillary tubing to about 2 mm and grinding the tip to about 0.5 mm with 400–600 mesh carborundum. About 0.0002 ml of solution is delivered by the described technique. Volumes of solution smaller than 0.0002 ml are delivered by the Gilmont Ultra-Microburet (The Emil Greiner Company, 161 6th Ave., New York City).

[6] Phenol which gives a red-colored solution is preferred since it marks the solvent boundary more clearly than chemically pure material. Pink fronts may be eliminated by treatment with coal gas, ammonia, HCN, or cupron (*1*).

An Improved Apparatus and Procedure for Ascending Paper Chromatography on Large Size Filter Paper Sheets

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The technique of ascending paper chromatography introduced by Williams and Kirby (*5*) represents a considerable simplification of the original technique of Consden, Gordon and Martin (*1*). However, the apparatus suggested by Williams and Kirby limits the possible size of two-dimensional chromatograms to about 11 in. × 11 in., and the actual chromatogram is usually considerably smaller when unused paper has been trimmed from the edges. The 6-gal stoneware crocks proposed, are quite heavy and unwieldy and become increasingly difficult to handle in larger sizes. Stoneware crocks have some other disadvantages: they are porous and tend to retain a particular solvent tenaciously; they are supplied with rounded edges difficult to seal properly unless a grinding operation is undertaken; and they have rounded inside bottoms which make it difficult to balance an ordinary flat-bottomed pan.

The apparatus to be described has made it possible to secure consistently good two-dimensional chromatograms by the ascending technique on 18 in. × 22 in. Whatman No. 1 filter paper sheets or on 23 in. × 23 in. S & S No. 604 filter paper sheets. The chromatography tank[3] itself is a 20-gal 26-lb stainless steel tank provided with two carrying handles, and having an inside height of 24 in. and inside diameter of 16 in. At the top, the wall is rolled outward to form a smooth flat flange, approximately ¾ in. wide. This flange acts as the lower surface of the lid-tank seal. The lid is a heavy plate glass disk to which a circle of soft rubber, approximately 1 in. in width, has been bonded by means of a Neoprene bond. The lid-flange junction provides a seal sufficiently good to permit a considerable reduction in the pressure within the tank without leakage, when suction is applied through an eccentrically placed 1-in. hole provided in the lid of the tank.[4] The eccentrically placed aperture provided in the lid is also useful for adding or removing material from solvent pans during a run, and may be used to introduce a thermostat and heating coil for temperature control.

Particular provision has been made for accurate leveling. Two spirit levels, separated by an angle of 90°, are permanently attached to the tank lid. The tank itself stands upon three legs, the length of which is individually adjustable. The leg length is sufficient to provide clearance for a spigot placed beneath the tank in order to drain flushing solutions or to drain solvent, when the entire tank base has been used as a solvent pan.

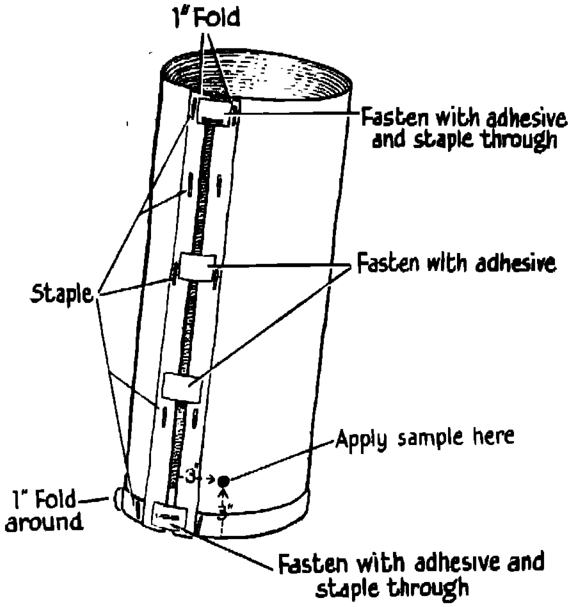
1" Fold
Fasten with adhesive and staple through
Fasten with adhesive
Staple
Apply sample here
3"
3"
1" Fold around
Fasten with adhesive and staple through

FIG. 1. Technique of folding and fastening large filter paper sheets. When the run is completed, the staples are carefully removed, and the adhesive tape cut. The sheet is hung for drying; and, if a two-dimensional chromatogram is contemplated, it is reformed into a cylinder and refastened after drying. At this time, excess adhesive from the first run is removed. Spots of material to be fractionated are best applied about 2 in. above the lower border and 2 in. in from the vertical border which is to be the lower border when the sheet is run in the second direction.

In general, the procedure used follows that of Williams and Kirby with few exceptions. Because the development of ascending chromatograms is slower than that of descending chromatograms, S & S No. 604, a more porous and softer paper than Whatman No. 1, is used under most circumstances and provides a considerably faster run than Whatman No. 1. The latter, however, should be used when solvents of high water content are employed, as in the protein experiments mentioned below, because of its stiffer quality.

The use of large paper sheets for ascending chromatograms requires a special technique to prevent bending or crumpling, since this will invariably occur if 18 in. × 22 in. or 23 in. × 23 in. sheets are merely stapled into a cylinder before standing in the solvent. Fig. 1 illustrates a technique of folding and fastening the borders of the cylinder which effectively overcomes the tendency to bend or crumple, even in solvents of high water content. The

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[1] We wish to thank Dr. Charles E. Dent of University College Hospital Medical School, London, for his advice on many points of chromatographic technique and for running the two-dimensional descending chromatograms in the case of cystinuria mentioned.

[2] This Department is in part supported by the Michael Reese Research Foundation.

[3] Photographs of the chromatography tanks are available upon request from the manufacturer. American Stainless Equipment Company, 2312 Greenview Avenue, Chicago, Ill.

[4] For runs with reduced tank pressure, a special stainless steel lid with a glass porthole is used.

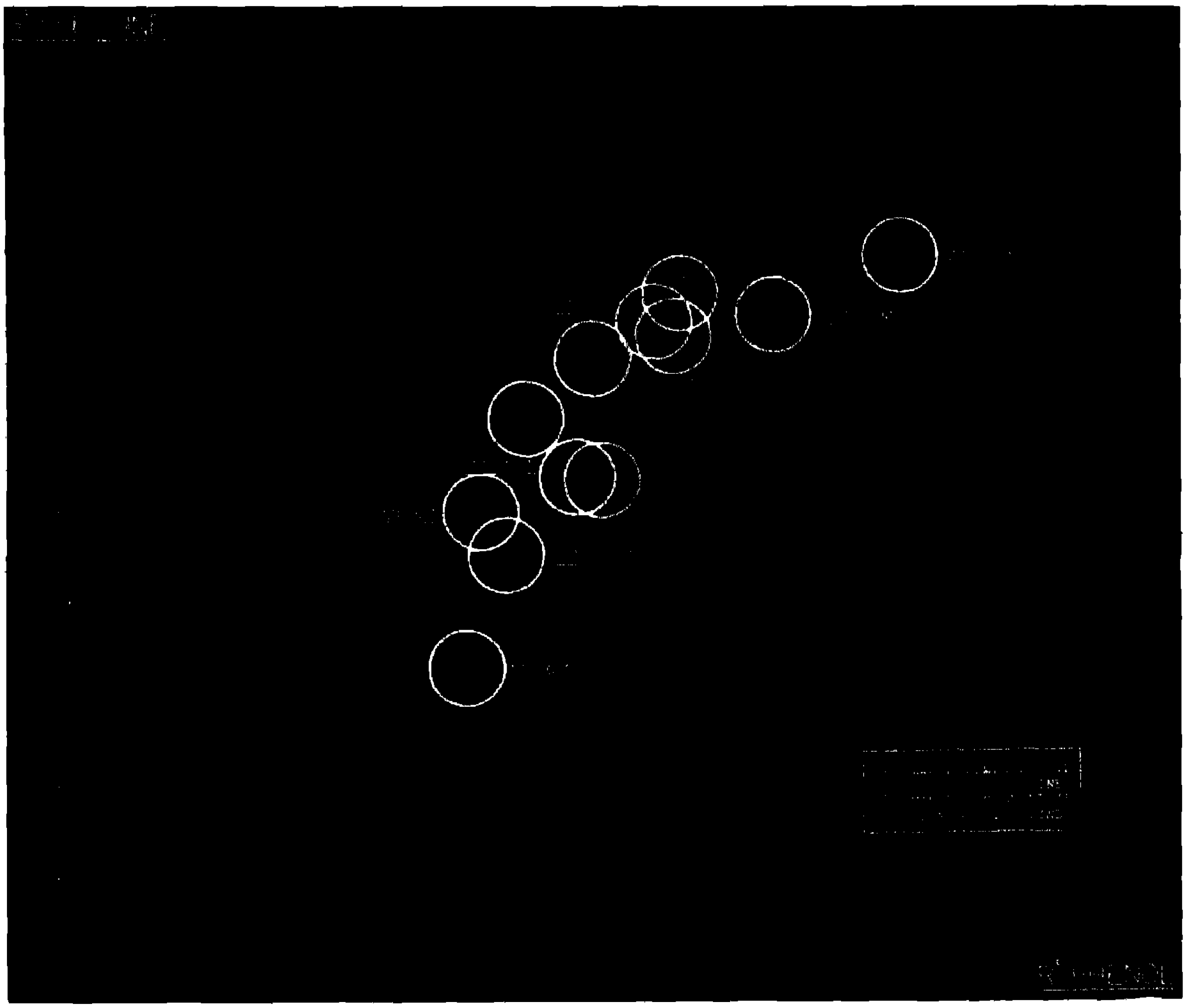

FIG. 2. Probable location of sugar spot centers on ascending chromatograms. The center of a particular sugar spot will fall in the circle in over two-thirds of the runs. Increasing temperature causes a rise in phenol R_f and a decrease in collidine R_f. To control such variation it is convenient to run a 1 µl spot of a standard solution, containing 5% rhamnose, xylose, arabinose, and galactose. The R_f of the unknown may then be corrected by multiplying the observed value by the fraction: theoretical average R_f of standard sugars ÷ observed average R_f of standard sugars.

staples used were ordinarily commercial staples; no difficulty attributable to metallic interference has been encountered. We have not noted the water-logging which Williams and Kirby found troublesome, possibly because all solvents, even when apparently free of emulsified or droplet water, are passed through a double thickness of large coarse fluted filter paper before being placed in the solvent pan, and refiltered if the filtrate is at all hazy. When this precaution is observed, ordinary water-saturated solvents give results which in our hands are superior to those obtained when using solvents saturated with saturated sodium chloride solution as recommended by Williams and Kirby (*5*).

Approximately 150 cc of solvent are placed in the solvent pan for a run on 23 in × 23 in paper. In the original technique of Consden, Gordon, and Martin (*1*), saturation of the atmosphere was maintained through the use of extra solvent-water and water-solvent pans. Such extra pans are not used in ascending chromatography, but a considerable excess of solvent is provided so that a saturated atmosphere may be obtained without significantly disturbing the concentration of the solvent with respect either to water or to solvent.

Large sheet ascending chromatography has been applied to a number of clinical problems with satisfactory results. In some respects, the technical quality of the ascending chromatograms exceeds that obtained by the descending technique, because of the virtual absence of tendency to develop irregular fronts.

Our R_f values for amino acids closely agree with those obtained by Williams and Kirby (*5*). R_f values for amino acids obtained by ascending and descending techniques are not directly parallel, although good parallelism obtains in the sugar series. Results obtained in the study of aminoaciduria by the two techniques have been identical. In a patient with cystinuria, both techniques detected the presence of excess amounts of lysine in each of two 24-hr urine samples with excess arginine in only one of the two samples. The apparatus and technique described have also been used in the partial development of a simplified procedure for the detection of purines on paper chromatograms (*5*).

Fig. 2 indicates the location of certain sugars of clinical interest on two-dimensional ascending chromatograms. A sample of urine from a patient with hereditary familial pentosuria yielded the two abnormal components, S^1 and S^2, shown on the grid. Studies to identify these components and a simplified procedure for the detection of sugars on paper chromatograms will be reported in a later communication (7).

The features of the tank design which permit operation at reduced pressures were introduced because of findings during preliminary attempts to fractionate protein mixtures and diazotized protein mixtures. In our experiments (*6*) and in those of Tiselius (*4*), it was found that when inorganic salt solutions were employed as developing solvents, no fractionation occurred unless water was permitted to evaporate from the solvent during the run. The results we obtained by casual evaporation did not prove sufficiently constant or precise for useful application; but by employing low, controlled vapor pressures, Tiselius (*4*) has obtained more promising results. Tiselius has also obtained distinct fractionation of protein mixtures on paper by a somewhat different technique, that of salting-out adsorption (*3*). In this procedure, the developing solvent is a salt solution which has a salt concentration approaching that at which the protein component of minimum solubility will precipitate.

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Electrical Still

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Many techniques, particularly the microdetermination of heavy metals, require metal-free water. Water from the usual steam tin-lined stills contains significant quantities of heavy metals and other foreign material, which necessitate redistillation of the water in an all-pyrex apparatus. The use of a Bunsen burner or an electric plate, as a source of heat, requires constant attention. The occasional cracking of the distillation flask when allowed to run dry, or after prolonged use, is a source of expense. Electrical heating elements can be employed; however, when in constant use, replacements are required.

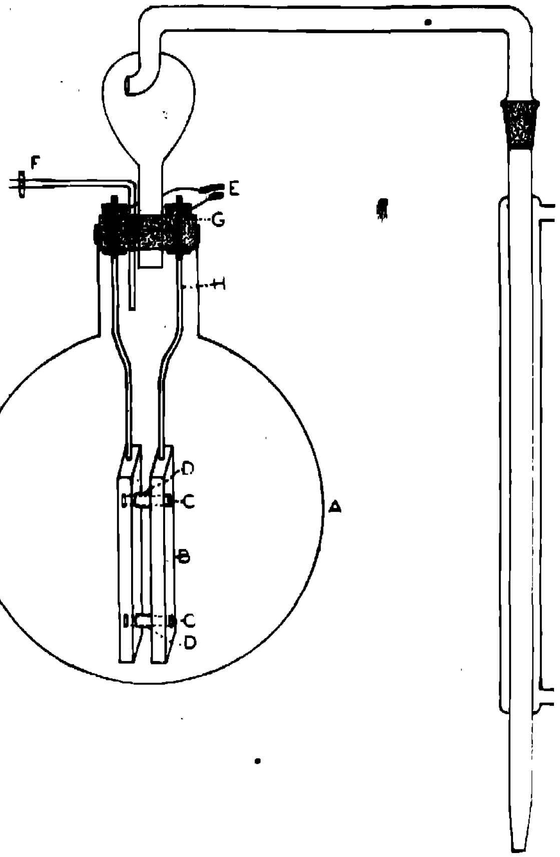

Fig. 1. (A) 5-liter flask. (B) Carbon electrodes, approximately 6 × 40 × 140 mm, which can be obtained at any electric motor shop. (C) Glass rods, 5 mm in diameter, with flattened ends to hold the carbon electrodes in place. (D) Glass tubes, 7 mm long, fitting snugly over the glass rods to keep the carbon electrodes apart. (E) Electric terminals connected to a 110-volt A.C. current. (F) Screw clamp on the water inlet from a 5-gal reservoir, adjusted so that the rate of the water dripping into the flask is in equilibrium with the rate of distillation. (G) Rubber stopper. (H) Brass rods, approximately 5 mm in diameter, fitted into the carbon electrodes and threaded on the upper end. The rods pass through the rubber stopper and are held in place with burrs.

It appears that a still (Fig. 1) which is easily constructed and requires a minimum amount of care and expense for its maintenance may well be of interest to other workers. It has the added advantage that the electric current to the heating element is automatically broken when the level of the liquid in the flask falls below the electrodes.

To operate the still, approximately 100 mg of sodium chloride are placed in the flask (*A*) to serve as a partial conductor for the current. The flask is filled about half full of water and the distilled water from a reservoir is allowed to drip into the flask at the same rate as the water is distilled. When this equilibrium is attained, it can operate without attention for many hours. This apparatus can supply about 5 gal of water in a 24-hr period. It should be added, however, that the use of the still herein described does not free the distillate from volatile substances such as carbon dioxide and ammonia.

Application of Probits to Sweet Corn Earliness Data

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Two widely used measurements for estimating earliness in maize are date of first tassel appearance and date when half the population have silked. Measurements are more liable to error when first tassel date is used than with the half-silking date, for in a normal population the earliest plants to flower are few compared with half the population in flower. Similarly, stragglers may flower very late, or not at all, and upset measurements of flowering spread used to indicate uniformity.

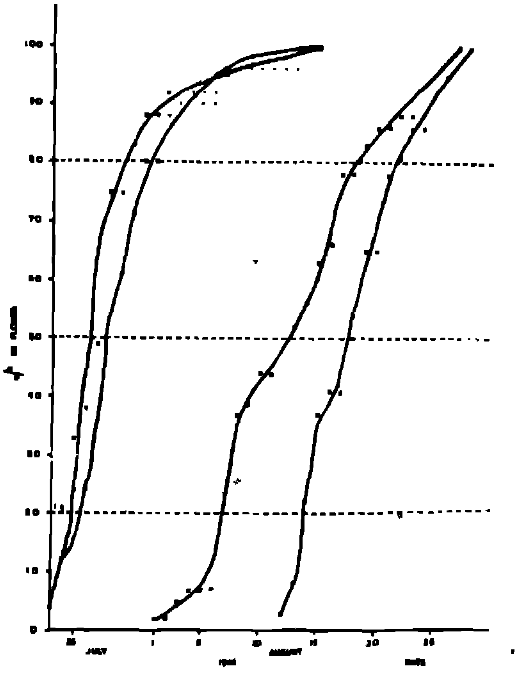

FIG. 1. Flowering (tassel) time for sweet corn variety *Dependogold* sown at 28-day intervals. Percentages plotted against actual date.

In England, where for breeding purposes it is important to get very early plants of sweet corn varieties, date of first tassel appearance has been used to measure earliness; this helps selection of the earliest plants. Unfortunately, earliest plants may be impeded by fruit fly damage and flower later than they are potentially capable of doing, thus increasing error.

Data for variety *Dependogold* were taken from an experiment to determine the best time for sowing sweet corn in England, four sowings having been made at 28-day intervals from the 1st of March 1946. Tassel date of each plant was recorded, and the percentage of plants in flower at a particular date for each sowing time was calculated and plotted (Fig. 1). Although irregular, the curves to some extent resemble the sigmoid curve characteristic of growth. Percentages were transformed to probits and plotted against logarithm of flowering date. Such transformed data of true sigmoid curves are expressed as straight lines drawn along the best fitting position, as shown by Finney (*1*). The transformed data for flowering times for the four sowing dates are given in Fig. 2. Here the dots lie reasonably close to the best fitting straight lines, although there is slight discrepancy for the earliest sowing which was based on few surviving plants.

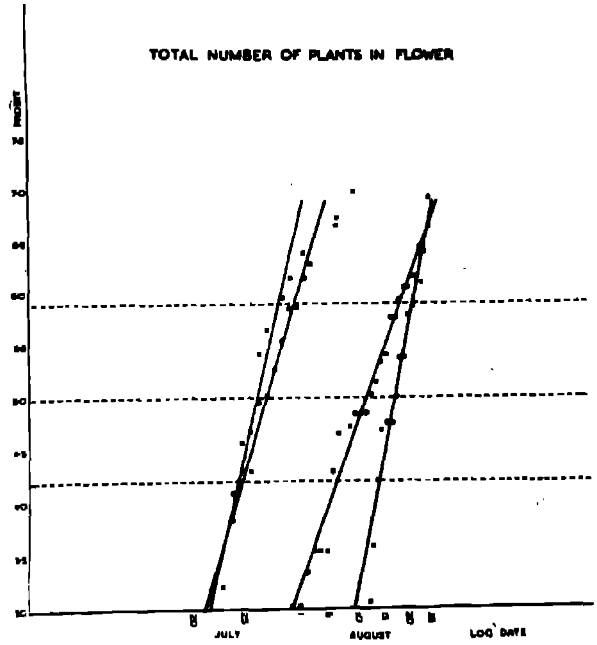

FIG. 2. Data from Fig. 1 transformed. Probits plotted against logarithm of flowering date.

The 5.0 probit value on any line gives the theoretical date for half the population in flower and is an index of earliness, like the 50% in flower of untransformed data. Angles of the slopes of the various lines indicate, too, how rapidly a variety flowers when sown at different times. Hence, for different varieties sown at the same time, this method would give an easy visual method of determining uniformity, the larger the angle the greater the uniformity.

The value of applying probits to plant breeding data in general should, therefore, not be overlooked.

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A Prothrombin Conversion Accelerator in Serum[1]

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Recently substances have been described in serum which activate or accelerate the conversion of prothrombin to thrombin by thromboplastin plus ionized calcium (*8*, *5*). These observations are of fundamental importance, since they help explain the autocatalytic process underlying the formation of thrombin.

We have found that human serum contains a substance which arises during blood coagulation and which is capable of accelerating the conversion of prothrombin to thrombin. This agent, distinct from thromboplastin or thrombin, can be separated from prothrombin-free serum and has been purified to the extent that all of the accelerating activity is contained in 20 mg of protein from 100 cc of serum. The substance is measured by its ability to accelerate the velocity of prothrombin conversion to thrombin when added to fresh normal plasma, the mixture then being suitably diluted with prothrombin-free plasma (*6*). The prothrombin time of the mixture is determined by the one-stage procedure and its prothrombic activity computed from a standardization curve obtained on normal plasma.

Some of the biochemical and physiological properties of the serum prothrombin conversion accelerator (spca) have been delineated: 1) It can be quantitatively adsorbed from serum by $BaSO_4$ or $BaCO_3$. 2) It can be eluted from the $BaSO_4$ by solutions of sodium citrate. 3) It is nondialyzable. 4) It is removed from serum by Seitz filtration. 5) It is not precipitated from diluted serum at pH 5.8. 6) It is destroyed in serum at 56° C in 2 min. 7) It is stable in serum at 4–5° C for at least 3 days, in purified fractions for at least 9 days, but is less stable in media which are free of electrolytes. 8) In serum it is destroyed below pH 5 and above pH 9. 9) It can accelerate the coagulation of normal or hemophilic blood. 10) Its effect on prothrombin conversion is not obviated by moderate amounts of heparin capable of retarding coagulation. 11) The amount of spca evolved during blood clotting is related to the amount of prothrombin consumed in the process. 12) It is increased by mechanical agitation of, or thromboplastin supplements to, clotting blood. 13) It is decreased by removal of platelets or by allowing blood to clot in siliconized tubes. 14) Preparations of spca obtained by $BaSO_4$ adsorption and elution with citrate have an ultraviolet absorption spectrum which is indistinguishable from prothrombin fractions obtained in the same manner from fresh human plasma.

In serum from patients with idiopathic hypoprothrombinemia, or with hypoprothrombinemia induced by dicoumarol, the amount of the serum accelerator is abnormally small. Similar observations were found also in thrombocytopenia, either idiopathic or secondary to other pathological conditions; in these instances residual serum prothrombic activity was much greater than normal.

Hemophilic serum frequently shows a prothrombic activity, by the modified one-stage procedure (*6*) that is considerably higher than that of the parent plasma. This is probably due, at least in part, to some spca which has evolved during coagulation.

It appears that the serum prothrombin conversion accelerator, described above, is different from the serum Ac globulin of Ware and Seegers, which is reported to be remarkably unstable in human serum (*7*). Nothing can be said regarding its identity or non-identity with factor VI of Owren (*5*). Detailed reports on some of these observations are in press elsewhere (*1–4*).

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[2] Aided by a fellowship from the Rothschild Hadassah University Hospital, Jerusalem.

A Linear Diffusion Method Suitable for Large Scale Microbiological Antibiotic Assay

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A diffusion method of microbiological antibiotic assay has been developed which appears to offer advantages of economy, accuracy, and concentration range of validity over Petri dish methods. This method involves linear diffusion of antibiotics into inoculated, agar-filled, glass capillaries from solutions of antibiotic in nutrient broth.[1]

Pyrex glass capillaries having an internal diameter of approximately 1 mm and length of 3½ in. are ground flat on one end. These are partially filled with melted agar seeded with test organisms. These capillaries are filled in an automatic device which molds the end of the agar column flat and flush in the end of the capillary. This flat end of the agar column serves as the initial boundary for diffusion and for the measurement of inhibition zone length.

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[1] Our attention has recently been directed to a paper—Torii, Toshio, Yasuo Kawakami, and Hiro Kosima. *Journal of Penicillin* (Japan) 1947, 1, No. 5, 281—describing the use of a system of linear diffusion for assay of antibiotics using test tubes partially filled with agar overlaid with a broth solution of the antibiotic.

Dilutions of antibiotics in nutrient broth are made up and poured into test tubes of such size as to accommodate two capillaries each. The volume of antibiotic solution is not important, about 2–4 ml being adequate. The test tubes containing antibiotic solution and capillaries are stoppered to prevent evaporation during incubation.

By a proper choice of test organisms and nutrient solution for each class of antibiotics, it is possible to find conditions which provide a sharp zone of intense aerobic growth of the test organism at the upper end of the inhibition column. Above this zone of growth almost no visible growth occurs, due to the absence of oxygen. The position of this sharp zone of aerobic growth depends upon concentration of the antibiotic. When the seeded agar is made with nutrient broth, the linear relation of log concentration versus zone length is approximated over the range from below 1 unit to above 1000 units per cc of streptomycin. If the seeded agar is made without nutrient, improved slope (zone length increase for a tenfold increase in concentration) results, but with a radical deviation from linear of the log concentration versus zone length curve.

Automatic devices have been provided for rapid reading of zone lengths and for cleaning of capillaries and test tubes with steam after completion of the experiment.

The method has been applied successfully to the assay of streptomycin, dihydrostreptomycin, penicillin-G, and an alkyl thiomethylpenicillin using *B. subtilis* spores. Sharper zones of aerobic growth have been produced in assays of streptomycin than of penicillin, but the method appears to be adaptable to any diffusible antibiotic. The special conditions optimal for this test depend strikingly on the antibiotic being tested, upon the composition of the nutrient broth, and upon pH.

A standard curve is prepared from a series of known dilutions of the antibiotic, and the potencies of the unknowns are referred to this curve.

Test procedure and equipment for carrying it out, as well as factors determining slope, sharpness of zones, and other aspects of performances, will be described elsewhere.

Potentiality for Testicular Recrudescence during the Annual Refractory Period of the Golden-crowned Sparrow

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The inability of the pituitary-gonad mechanism of adult and immature golden-crowned sparrows (*Zonotrichia coronata*) to respond to light stimulation in the early autumn following arrival on the winter range has been demonstrated by experiments recently reported (*3*). This refractoriness was thought to be an attribute of the pituitary gland, but conceivably the gonad is refractory instead, or in addition. In the autumn of 1948, during the refractory period of this species, gonadotropic hormone was administered to five males; two others served as controls. Pregnant mare serum was used (gonadin) from a preparation kindly furnished by the Cutter Laboratories of Berkeley. Daily dosage consisted of 1 cc of serum which contained approximately 50 international units. Controls received the same amount of physiological saline. Injections were made intramuscularly in the breast. Treatment began on October 19, some two weeks after completion of the fall migration, and all birds were autopsied by November 3 before the known conclusion of the light-refractory period.

The response of the testis was rapid and decisive in all experimental individuals. Increase in volume of the left testis from less than 1 mm^3 to 4.2 mm^3 occurred in 4 days; and one individual at the end of 14 days attained a testis volume of 20.9 mm^3. Histologically this largest testis had reached stage 4 of Blanchard (*1*), with functional interstitial cells and primary spermatocytes in synapsis. The controls showed volumes of 0.26 mm^3 and 0.78 mm^3 at the end of the experiment on November 3.

The results indicate that the testis is able to respond to follicle-stimulating hormone during the period when this species of sparrow is refractory to increasing light dosages. The experiment, of course, does not eliminate the possibility that the testis at that time is unresponsive to the gonadotropic hormone of its own pituitary or that it may have a somewhat elevated threshold of response during that period. There seems no doubt, however, that the testis is capable of recrudescence if given a sufficient stimulus. Moreover, this is true equally of the immature testis that has never before enlarged and of the adult testis that previously has been functional, since both immature and adult birds were included in the experiment.

Kirschbaum *et al.* (*2*) have reported that the testis of young male English sparrows (*Passer domesticus*) can be stimulated at an early age by pregnant mare serum; adults also respond. However, in this species refractoriness to light stimulation occurs only in the adult in the autumn, immature birds showing recrudescence at that season, according to Riley (*4*). Nevertheless, the situation seems to be similar in the two species with respect to the capability of the testis to respond at all times to gonadotropic hormone and the apparent responsibility of the pituitary for refractoriness to light when and if this appears. Caution must be sounded against assuming that there are identical physiological mechanisms or systems of response in these species of sparrows, for the English sparrow is actually misnamed a sparrow and belongs to the weaver finch group, currently recognized as a family distinct from the Fringillidae to which the golden-crowned sparrow belongs. Moreover, the English sparrow is nonmigratory.

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Comments and Communications

Action of Coal-tar Dyes and Related Compounds on α-Amino Acids

Recently, it was found (Schönberg, Moubasher, and Mustafa, *J. Chem. Soc.*, London, 1948, 176) that bacteriostatic agents related to benzil, e.g., 2-hydroxy-2′-methoxybenzil are capable of reducing α-amino acids having the structure (I) to the corresponding aldehydes containing one less carbon atom, in an aqueous medium under physiological conditions of temperature and pH (e.g., alanine ⟶ acetaldehyde; phenylaminoacetic acid ⟶ benzaldehyde). The theory was advanced that the bacteriostatic action of these substances is connected with this reduction, since they destroy α-amino acids essential for the bacterium and they interfere with its enzyme system.

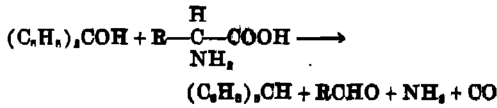
Systematically investigating substances showing bacteriostatic action, we found that crystal violet and malachite green (Jordon and Barrows, *Comp. textbook of bacteriology*, 13th ed., 1941, p. 69) rapidly reduce α-amino acids and we wish, as in the case of 2-hydroxy-2′-methoxybenzil, to connect their bacteriostatic action with their power of reducing α-amino acids.

The spermatocidal action of certain triphenylmethane dyes and of *p*-quinones, e.g., toluquinone and crystal violet (Schönberg, *et al.*, *loc. cit.*, and Clark, *Applied pharmacology*, 7th ed., London: 1940, p. 564), should be explained in a similar manner.

It seems that a general principle has been found which enables us to predict that water soluble substances capable of reducing α-amino acids to the corresponding aldehydes containing one less carbon atom will show bacteriostatic and spermatocidal action.

The parent substance of these coal-tar dyes, namely triphenylcarbinol, is also capable of bringing about the reduction of α-amino acids, because its hydroxyl group is very active.

As triphenylcarbinol is not easily soluble in water, its action on α-amino acids was studied in a mixture of water (2 vol.) and acetic acid (3 vol.). The reduction proceeds as follows:



$$(C_6H_5)_3COH + R\text{—}\overset{\displaystyle H}{\underset{\displaystyle NH_2}{C}}\text{—}COOH \longrightarrow (C_6H_5)_3CH + RCHO + NH_3 + CO_2 \qquad (I)$$

Crystal violet (1.5 g), phenylaminoacetic acid (0.3 g), and water (50 cc) were refluxed for 40 min in a stream of carbon dioxide in a distilling flask provided with a condenser dipping into an aqueous-alcoholic solution of phenylhydrazine hydrochloride; benzaldehyde phenylhydrazine (0.2 g) was obtained.

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Neurospora as an Object of Genetic Study—a Correction

In summarizing the history of the study of *Neurospora* (*Science*, 1948, 108, 735), David M. Bonner has written: "The life cycle of this organism had been worked out by the mycologist, Dodge, and the usefulness of *Neurospora* as a genetic tool had been demonstrated by the geneticist, Lindegren." This statement implies a somewhat startling disparagement of the important and widely recognized contribution to biology embodied in the series of papers on *Neurospora* published by B. O. Dodge. In justice to all concerned, and for rectification of the historical record, a further note seems necessary.

The very earliest of the accounts of *Neurospora*, that published by Shear & Dodge in 1927 (*J. agric. Res.*, 34, 1019), dealt not only with the taxonomy and life cycle (connection of conidial and ascigerous stages) of the genus, but also with hybridity and with the most important of its genetical properties, heterothallism. A sequel, published by Dodge in the same year (*J. agric. Res.*, 35, 289) described the cytological bases for hetero- and homothallism in *Neurospora.* In 1928 (*J. agric. Res.*, 36, 1) Dodge reported an amplification of his original study of interspecific hybrids in the group, and the recovery of the parental types, and later in the same year (*Mycologia*, 20, 226) the segregation of parental types in conidia borne on miktohaplontic mycelium. In 1929 Dodge demonstrated the place of segregation of mating factors and of factors for conidial types (*Mycologia*, 21, 222; 22, 9), and in 1931 issued a study of the inheritance of these factors in interspecific crosses (*Mycologia*, 23, 1). Early in 1932 (*Torrey Bot. Club Bull.*, 59, 517) he refuted a claim that the fructification of *Neurospora* is apogamous.

For an organism to be a useful genetic tool it should be, one would suppose, capable of easy cultivation, amphimictic, and possessed of readily distinguishable alleles. In addition to these, *Neurospora* possesses further sources of usefulness not shared by most genetic material: 1) the haploid generation is susceptible of indefinite propagation and multiplication, so that there can be produced any number of identical cells of known genetic composition and capable of behaving as gametes; 2) the exact cytological interrelations of all the cells arising from a single zygote can be determined, so that cytological and genetic phenomena can be directly correlated; and 3) all the products of a single meiosis can be recovered, related, and identified, so that the exact products of one meiosis, rather than the statistical results of many, can be analyzed. All of these attributes of *Neurospora* were demonstrated by Dodge in the papers cited; and in more than one place he pointed out that *Neurospora* is a profitable and significant object of genetical study. All of this work was in print before the publication of Lindegren's first paper on the genus (*Torrey Bot. Club Bull.*, 59, 85). Because of Dodge's demonstration of ''the usefulness of *Neurospora* as a genetic tool,'' T. H. Morgan had asked for cultures of the species and strains employed in Dodge's studies; these Morgan subsequently turned over to Lindegren. Beginning in 1932 both Dodge and Lindegren made frequent contributions to the growing knowledge of the genetics of *Neurospora;* and Dodge's work continues. It does not detract in the least from the considerable interest of Lindegren's work to insist that the discovery and development of these fungi as means of bringing to light additional knowledge of genetic processes were accomplished by ''the mycologist, Dodge,'' before Lindegren ever undertook work on the group.

With the record set straight on the one point, a moment's attention may be devoted to a matter of terminology. A mycologist, it is assumed, is one who works with, studies, and knows something abount fungi. A mycologist, like a bacteriologist, botanist, zoologist, or microbiologist, may be a taxonomist, morphologist, cytologist, physiologist, geneticist, or ecologist, or several or all of these. One group of subdivisions of biology, according to organisms studied, is intersected by the other, based on aspects studied; thus far no two of them, fortunately, are mutually exclusive.

DONALD P. ROGERS

New York Botanical Garden

Reply to D. P. Rogers

In a recent paper published in *Science* (1948, 108, 735), I summarized very briefly the work leading to the adoption of *Neurospora* by G. W. Beadle and E. L. Tatum for investigation of the genetic control of biochemical reactions. It is difficult in a few words to do ample justice to various investigations spanning a number of years, and D. P. Rogers has written outlining much more fully the fundamental contributions of B. O. Dodge to the biology of *Neurospora.* I agree with Rogers' insistence that discovery and development of *Neurospora* as a genetic tool should be credited to Dr. Dodge.

In terms of the use of this organism for investigations in the field of biochemical genetics, however, one cannot omit the contribution of C. C. Lindegren. Lindegren's work on the genetics of *Neurospora* played an important role in the selection of this organism by Beadle and Tatum. Thus I feel that the investigations of both Dodge and Lindegren merit particular mention when discussing the biology of *Neurospora.*

DAVID M. BONNER

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Scientific Book Register

BIRKELAND, JORGEN. *Microbiology and man.* (2nd ed.) New York: Appleton-Century-Crofts, 1949. Pp. xii + 525. (Illustrated.) $5.00.

BLOOM, WILLIAM. (Ed.) *Histopathology of irradiation from external and internal sources.* (National Nuclear Energy Series IV-22I). New York: McGraw-Hill, 1948. Pp. xxv + 808. (Illustrated.) $8.00.

DAUS, PAUL H., and WHYBURN, WILLIAM M. *First year college mathematics with applications.* New York: Macmillan, 1949. Pp. xiii + 495. (Illustrated.) $5.00.

DUNBAR, CARL O. *Historical geology.* New York: John Wiley; London: Chapman & Hall, 1949. Pp. xii + 567. (Illustrated.) $5.00.

FAXON, NATHANIEL W. (Ed.) *The hospital in contemporary life.* Cambridge, Mass.: Harvard Univ. Press, 1949. Pp. 288. $5.00.

FRANCIS, CARL C. *Introduction to human anatomy.* St. Louis: C. V. Mosby, 1949. Pp. 470. (Illustrated.) $5.50.

FRANKENBURG, W. G., KOMAREWSKY, V. I., and RIDEAL, E. K. (Eds.) *Advances in catalysis and related subjects.* New York: Academic Press, 1948. Pp. xiii + 321. (Illustrated.) $7.80.

FREBERG, C. R., and KEMLER, EMORY N. *Elements of mechanical vibration.* (2nd ed.) New York: John Wiley, 1949. Pp. xiii + 227. (Illustrated.) $3.75.

HOUWINK, R. (Ed.) *Elastomers and plastomers: their chemistry, physics and technology.* (Vol. III.) *Testing and analysis; tabulation of properties.* New York: Elsevier Publ., 1948. Pp. 174. (Illustrated.) $4.50.

LEITNER, S. J. (English translation revised and edited by C. J. C. Britton and E. Neumark.) *Bone marrow biopsy haematology in the light of sternal puncture.* New York: Grune and Stratton, 1949. Pp. xi + 438. (Illustrated.) $8.50.

LYONS, WILLIAM R., and WOODHALL, BARNES. *Atlas of peripheral nerve injuries.* Philadelphia-London: W. B. Saunders, 1949. Pp. 339. (Illustrated.) $16.00.

MONGE, CARLOS. *Acclimatization in the Andes: historical confirmations of ''climatic aggression'' in the development of Andean man.* Baltimore, Md.: Johns Hopkins Press, 1948. Pp. xix + 130. $2.75.

RICE, FRANCIS OWEN, and TELLER, EDWARD. *The structure of matter.* New York: John Wiley; London: Chapman & Hall, 1949. Pp. xiii + 361. (Illustrated.) $5.00.

———. *Tables of Bessel functions of fractional order.* (Vol. II.) (Computation Laboratory of the National Applied Mathematics Laboratories, National Bureau of Standards.) New York: Columbia Univ. Press, 1949. Pp. xviii + 365. $10.00.

NEWS and Notes

Edwin J. Cohn, professor of biological chemistry, Harvard Medical School, and chairman of the Medical Sciences Division of the Faculty of Arts and Sciences, has been named a university professor of Harvard. Dr. Cohn is the first scientist to hold a university professorship. His appointment follows the retirement last year of **Roscoe Pound**, the first scholar to receive the appointment. The other university professors are: **Werner W. Jaeger**, classicist; **Sumner H. Slichter**, economist; and **I. A. Richards**, humanist.

Edwin H. Land, president and director of research of the Polaroid Corporation, Cambridge, Massachusetts, is planning a trip to England and the Continent for the late spring. May 31, he will address the Royal Photographic Society on "A New Camera and One-Step Photographic Process," June 1, The Royal Institution on "Optical Polarizers," and June 2, The Physical Society on "A Color Translating Ultraviolet Microscope."

Dugald E. S. Brown, director of the Bermuda Biological Station for Research, has been appointed chairman of the Department of Zoology at the University of Michigan. He will assume his duties on September 1, succeeding George R. LaRue, who will continue as professor of zoology.

Clarence Crafoord, cardiac specialist of Sweden, has been made an honorary doctor of medicine by the University of Grenoble, France. On May 28, his 50th birthday, Dr. Crafoord will receive a fund raised by the Swedish people to support his work in heart surgery.

Henry De Wolf Smyth, chairman of the Department of Physics, Princeton University, has been appointed a member of the U. S. Atomic Energy Commission. Dr. Smyth was the author of "Atomic Energy for Military Purposes," the U. S. official report on the development of the atomic bomb. His appointment follows the resignation of **Robert F. Bacher** who will become professor of physics and chairman of the Division of Physics, Mathematics, and Astronomy of the California Institute of Technology, effective this summer.

Norman R. Beers, head of the meteorology group at Brookhaven National Laboratory, has been appointed editor of *Nucleonics*. He will continue as consultant for the Department of Reactor Science and Engineering at Brookhaven.

George P. Berry, associate dean of the School of Medicine and Dentistry at the University of Rochester, has been appointed dean of the Harvard Medical School, effective July 1. Dr. Berry succeeds **C. Sidney Burwell**, who has resigned to devote his full time to teaching and research.

Visitors to U. S.

Jens Nielsen, medical director of Radium Center and Finsen Institute, Copenhagen, was a recent visitor at the Argonne National Laboratory, Chicago.

Alexander Muir, chief of the Soil Survey in England and Wales, and head of the Department of Pedology of the Rothamsted Experimental Station, is visiting soil survey groups in various parts of the country. He will also serve as a delegate at the United Nations Scientific Conference on the Conservation and Utilization of Resources, to be held in New York this fall.

Grants and Awards

The University of Buffalo has been granted $29,370 by the Veterans Administration for research on "Psychological Adjustment to Hemorrhage and the Fate of the Transfused Red Blood Cell." The grant, made through the National Research Council, is for one year and is renewable as the project continues. John D. Stewart, professor of surgery, and chairman of the Department of Surgery of the Medical School, will head the project. He will be assisted by three major investigators: Edgar L. Hummel, hematologist; Joseph G. Hoffman, biophysicist; and Irving Rudman, surgical assistant.

The **Torrey Botanical Club** has made awards from its Mary S. Andrews Research Fund to Robert T. Clausen, Department of Botany, Cornell University, for a taxonomic study of the genus *Sedum* in the Sierra Madre Oriental of Mexico; to Richard Goodwin, Connecticut College, for a study of fluorescing substances in roots; to Charles Heimsch, University of Texas, for comparative anatomical studies of angiospermous families; and to Brother Leon, Colegio de La Salle, to assist in the preparation of volumes on the *Flora de Cuba*.

The New Orleans Academy of Sciences and the **American Association for the Advancement of Science** have awarded their 1949 research grant to H. S. Mayerson and J. K. Hampton, Jr., both of the Department of Physiology, Tulane University School of Medicine, to further their investigations of the histological site of deposition of ferritin in the kidney.

Fellowships

The Department of Physics, University of Southern California, has announced the availability of graduate teaching and research assistantships for the academic year 1949–50. Half-time assistants, with 12 hours of laboratory supervision a week, will receive tuition plus $800 to $1,000. Applicants should write to John R. Holmes, Department of Physics, University of Southern California, Los Angeles 7.

The American College of Physicians has announced that a limited number of fellowships in medicine will be available from July 1, 1950 to June 30, 1951. They will provide research training in the basic medical sciences or in their application to clinical investigation at a stipend of $2,200 to $3,200, facilities to be provided by the laboratory or clinic chosen by the applicant. Applications may be obtained from the American College of Physicians, 4200

Pine Street, Philadelphia 4. Awards will be announced in November, 1949.

Colleges and Universities

Marshall College, Huntington, West Virginia, laid the cornerstone of its $2,000,000 science building last month. The structure, to be completed in 1950, will house classroom and complete laboratory facilities for the biology, botany, zoology, geology, chemistry, and physics departments.

The McCollum-Pratt Institute of Johns Hopkins University will begin July 1 the trace element studies made possible by a gift from John Lee Pratt in January, 1948 (see *Science*, 107, 186). William D. McElroy has been made director of the institute, and Robert Ballantine and Alvin Nason have been named staff members. The unit plans to study the role of micronutrients in the metabolism of plants and animals, to hold periodic conferences on research problems, and to make available pre- and post-doctoral fellowships in the field of micronutrients.

Meetings and Elections

ASA 20th Anniversary. The American Acoustical Society held its 20th anniversary meeting in New York City May 5–7. The theme of the meeting was "Acoustics and Man," and papers were classified according to function in the following categories: "Acoustics in Communication"; "Acoustics in the Arts"; "Acoustics in Comfort and Safety"; and "Acoustics in Research." Invited papers on these subjects were presented, in addition to the contributed papers.

Vern O. Knudsen warned that in many occupations, such as riveting, blasting, and jet propulsion, noise levels are so high that the health of workers is endangered. A noise level from 120 to 150 decibels "can destroy hearing, excite vestibular disturbances, and cause other serious injury," he said. In subways the level often reaches 100 decibels. England, Sweden, Denmark, and Holland have sound-insulation procedures worthy of emulation, Dr. Knudsen said, and he recommended stricter zoning and building codes for this country. Another speaker who decried noise was Leo L. Beranek, and he proposed adequate sound-proofing to combat it. U. S. sound-proofing standards are much lower than those in England and other countries, he said.

William B. Snow described means for controlling some of the noisiest of industrial operations. In a ram jet motor test station operated by John Hopkins University during the war test cells were built with double concrete walls separated by dead air space, and the cells were enclosed with heavy double doors pulled against rubber seals.

Homer Dudley presented a paper by T. H. Tarnoczy, of Budapest, predicting that scientists may well develop electrical devices which will analyze and synthesize speech sounds "so that the human voice can give commands which will be . . . carried out automatically without the intervention of a single human hand."

Harry F. Olson stated that education and culture have been as much advanced by the reproduction of sound through the telephone, radio, phonograph, and motion picture as they were by the invention of the printing press.

Philip Morse said that one of the major lessons of war research was the immense value of close cooperation among specialists in varied fields. "We have no iron curtains in science in this country," he said, "nor will we as long as we keep our channels of intercommunication open and busy." Because progress in one field often produces results applicable in another, Dr. Morse feels that it behooves scientists to keep abreast of developments on the entire front of scientific research.

A sensitive electroacoustic instrument for detecting gallstones was described by E. G. Thurston. Passed along the bile ducts, the instrument, when is reaches a gallstone, produces a clicking sound in headphones worn by the surgeon.

A founders' luncheon was attended by a considerable fraction of those far-seeing members who 20 years ago assembled on the roof of the Bell Telephone Laboratories at 463 West Street for a photograph, after completing the plans for organization of the Acoustical Society of America. This group was photographed again at the recent luncheon, 20 years older, 20 decibels wiser. These founders could be identified by their white carnations and justifiable air of pride.

Since the society got its start at the Bell Telephone Laboratories, it was appropriate that Friday should be spent in a tour of the beautiful new Bell Laboratories at Murray Hill, New Jersey. Half the day was spent in visiting various portions of the laboratory devoted to acoustical research, and the other half in attending a series of demonstration lectures in the Arnold Auditorium. We all know that sound will travel around curves inside a tube, but Winston E. Cook showed sound following a curve along the outside of a rod covered with discs about the size of a penny and half an inch apart.

Harvey Fletcher, first president of the society, was presented with a Certificate of Honorary Membership by his one-time student, Vern O. Knudsen. Divertissement was conducted by the society's humorist, Pat Norris, who outlined the advances in acoustics made during his 20 years of membership, starting with the open window unit of sound absorption and ending with the vastly improved modern sound recording systems which now require three turntable speeds instead of one.

FLOYD FIRESTONE

Those wishing to submit papers on education at the AAAS December meeting should mail abstracts of proposed topics to D. A. Worcester, Secretary, Section Q, Department of Educational Psychology and Measurements, University of Nebraska, Teachers College, Lincoln 8, Nebraska, not later than *July 1*.

The American Institute of Chemists at its annual meeting, May 6, in Chicago, announced the election of the following councilors: councilor for one-year term: Roy H. Kienle, director of application research, Calco Chemical Division of American Cyanamid Company, Bound Brook, New Jersey; councilors for three-year terms: Donald Price, technical director, Oakite Products, Inc., New York City; Charles P. Neidig, Chemical Products Division, Atlantic Refining Company, Philadelphia; and Charles C. Concannon, chief of Chemical Division, Bureau of Foreign and Domestic Commerce, Washington, D. C.

NRC News

The National Research Council has announced 15 awards of the **National Research Fellowships in the Natural Sciences.** These fellowships are supported by an appropriation from the Rockefeller Foundation, and are to aid the further training of persons who have demonstrated a high order of ability in research in the natural sciences. The fellowship program, one of the oldest in the sciences, has been continuously administered by the NRC for 30 years.

This year's awards were distributed among the fields of astronomy (1), biology (1), botany (2), chemistry (4), mathematics (2), psychology (1), physics (3), and zoology (1). The new fellows, the universities and institutions at which they will study, and their subjects of research are: *Robert S. Bandurski*, California Institute of Technology, mechanism of carotenoid pigment synthesis in plants; *Philip J. Bersh*, Columbia University, effect of severable variables upon action of secondary reinforcing stimuli; *Jerome A. Berson*, Harvard University, the structure of emetine; *Verne E. Grant*, Stanford University, genetics and systematics of *Gilia multicaulis*, *Gilia achilleaefolia*, and their allies; *Walter E. Kaskan*, Johns Hopkins University, spectroscopic compounds; *William R. Krigbaum*, Cornell University, solubility of polymeric materials; *Edwin E. Moise*, Institute for Advanced Study, the triangulation of classical 30 manifolds; *Richard O. Recknagel*, University of Wisconsin, enzyme localizations in tissue homogenates; *Charles Max Stein*, Institute Henri Poincaire, Paris, sequential estimation; *Carl B. Seligman*, Physikalisches Institut der Eidg. Techn. Hochscule, Zürich; quantum field theory and applications to nuclear problems; *Alfred S. Sussman*, University of Pennsylvania, metabolic changes induced by parasitism; *Warren H. Watanabe*, Columbia University, effect of solvent basicity on the rate of an acid catalyzed reaction; *Marshal H. Wrubel*, Princeton University Observatory, radiative transfer in interstellar space; and *Sydney C. Wright*, Institute of Nuclear Studies and the University of Chicago, the nature of fission, stars and spallation in high energy nuclear reactions.

Fellowship renewed for another year: *Norman M. Kroll*, Institute for Theoretical Physics in Copenhagen, higher order effects in quantized field theories, and the problem of the deuteron.

Deaths

Raymond McCreary Hann, 49, chief of the Chemistry Section, National Institutes of Health, Bethesda, Maryland, died May 3 at the Marine Hospital in Baltimore. Dr. Hann joined the institute in 1929 and did research in sugar chemistry.

William B. Herms, 72, professor emeritus of parasitology and entomology at the University of California, died May 10 of a heart attack at Berkeley, California.

Harry M. Davis, 38, science editor of *Newsweek*, drowned in the Gulf of Mexico on May 16. Mr. and Mrs. Davis were vacationing at Biloxi, Mississippi at the time.

An eight-man board of judges to determine the winners of two $1,000 **AAAS-George Westinghouse Science Writing Awards** for 1949 has been announced. The judges, chosen as representatives of the general public, science, newspapers and magazines, are: Morris Meister, retiring president of the National Science Teachers Association; Henry R. Aldrich, secretary, Geological Society of America; Detlev Bronk, president, The Johns Hopkins University and chairman, National Research Council; Kent Cooper, executive director, The Associated Press; John R. Dunning, nuclear physicist, Columbia University; Clifton Fadiman, a member of the board of judges of the Book-of-the-Month Club; Rudolph Flesch, readability consultant, and Edward Weeks, editor, *The Atlantic Monthly*. Dr. Meister is chairman of the board of judges.

One award of $1,000 will be made to the writer of what the judges consider to be the outstanding news story on science published in 1949, and the other award of $1,000 will go to the writer of the outstanding article on science published during the year in a general circulation, nontechnical magazine. The awards will be presented next December 28 at the annual meeting of the AAAS in New York City.

In announcing the judges, Howard A. Meyerhoff, administrative secretary of the AAAS, emphasized that the annual competition was established four years ago to encourage young writers to take up careers in science writing. "The young writer," he said, "has a good chance to win $1,000 if his work shows initiative, originality, scientific accuracy, and clarity of interpretation. The only other requrement—and this is certainly not a formidable one—is that in the newspaper competition the contestant must submit three science stories published during 1949 as evidence of bona fide interest and continuity of effort in science writing for newspapers. There is ample time—four months remain—for interested news writers to qualify."

Science writers honored in the past and no longer eligible for the $1,000 award in the newspaper competition are: Howard W. Blakeslee, Associated Press; Watson Davis, Science Service; David Dietz, Scripps-Howard newspapers; Thomas R. Henry, *Washington Star* and North American Newspaper Alliance; Waldemar Kaempffert, *New York Times*; Gobind Behari Lal, *American Weekly*; William L. Laurence, *New York Times*; Herbert B. Nichols, *Christian Science Monitor*; John J. O'Neill, *New York Herald Tribune*;

Robert D. Potter, writer and consultant; Jane Stafford, Frank Thone and Marjorie Van de Water, all of Science Service; James G. Chesnutt, *San Francisco Call-Bulletin*; George Keaney, *New York World-Telegram*; and Frank Carey, Associated Press. An award in the newspaper field, however, does not exclude a writer from competing for the $1,000 magazine award.

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The Atomic Energy Commission on May 22 issued the following statement concerning the fellowship program now being administered by the National Research Council:

"Since the fellowship program is entirely supported by Federal funds, each AEC fellow, whether his study is in secret or non-secret fields, who desires to continue participation in the program, will be required to execute an oath to support and defend the Constitution of the United States and an affidavit that he is not a Communist or a member of any organization advocating the overthrow of the United States Government. The oath and affidavit are similar to those which are required of all government employees.

"The action taken with respect to the oath and affidavit to be executed by fellows is in accord with statements made this week by officers of the Commission, the National Research Council, and the National Academy of sciences appearing before the Congressional Joint Committee on Atomic Energy and the Independent Office Subcommittee of the Appropriations Committee of the Senate.

"The officers of the Academy and the Council also outlined to the Congressional Committees the responsibilities those bodies bear under their terms of organization to serve governmental agencies (1) by advising on scientific matters and (2) on the request of governmental agencies by carrying on specific programs within the field of their scientific competence. The work of the Council in the AEC fellowship program is undertaken to discharge the second of these responsibilities.

The Executive Committee of the National Research Council will consider in accordance with their usual practice additional modifications in the procedures to be used in the future for selection of those to receive fellowship awards.

"Of the 497 present fellows in the medical, biological and physical sciences affected by today's action, 240 are holders of fellowships to become effective in the 1949–50 academic year after July 1, 1949; 257 are at work under fellowships for the current academic year. Of these latter, 103 have been investigated by the FBI and cleared by the Commission for access to restricted data, since they are engaged in secret research and study. The remaining 154 are doing non-secret research and study."

The Federation of American Scientists issued the following statement on May 5 concerning the dismissal of Ralph Spitzer by A. L. Strand, president of Oregon State College:

"The Federation of American Scientists is concerned about implications for scientific freedom involved in the charges made by Dr. A. L. Strand, president of Oregon State College, in justifying his decision not to renew the contract of Dr. Ralph Spitzer, associate professor of chemistry. The basic charge made against Spitzer is that he is a follower of the Communist party line. Statements received by the Federation from Spitzer and Strand show that the only evidence presented publicly in support of the charge against Spitzer is a letter written by him to a technical journal. From this Strand concludes that Spitzer 'quotes the charlatan Lysenko in preference to what he must know to be the truth. . . . Any scientist who has such poor power of discrimination so as to choose to support Lysenko's Michurin genetics against all the weight of evidence against it is not much of a scientist, or, a priori, has lost the freedom that an instructor and investigator should possess.' Spitzer pointed out that in his letter he did not 'support or accept Lysenko's theories.'

Without passing judgment on the validity of any biological theory, the Federation nevertheless is concerned about the issue of orthodoxy in scientific thought which appears to be raised in the charges of the Oregon State College president. No scientific theory is 'right' or 'wrong' just because it is espoused by a particular national group or government. The validity of scientific theories ought to be determined, now and in the future, just as it has in the past—by experimental methods. It is deplorable that Lysenko's theory has been made a matter of national policy of the USSR; it would be equally deplorable to make *any* theory, in any field of science, a matter of national doctrine. There is no surer way to stifle science.

Present scientific knowledge does not entitle anyone to be dogmatic about the nature of hereditary processes. Genetic theory is undergoing continuous modification under the impact of new facts gathered both in the United States and abroad. This process in hindered when decree is substituted for the time-tested method of experiment and scientific discussion—whether this is done by exponents of the Lysenko school, or by the president of Oregon State College. In the long run, the principle of free scientific thought and opinion will prove more important than the fate of any individual theory."

Make Plans for—

American Medical Association, annual meeting, June 6–10, Atlantic City, New Jersey.

American Neurological Association, annual meeting, June 13–15, Chalfonte-Haddon Hall, Atlantic City, New Jersey.

Molecular Structure and Spectroscopy Symposium, June 13–17, Mendenhall Laboratory of Physics, Ohio State University, Columbus.

Pacific Division of the AAAS, 30th annual meeting, June 13–18, University of British Columbia, Vancouver.

American Mathematical Society, 3rd annual symposium in applied mathematics, June 14–16, University of Michigan, Ann Arbor.

American Society of Mammalogists, annual meeting, June 14–17, U. S. National Museum, Washington, D. C.

The Education of a Scientific Generalist

Hendrik Bode, Frederick Mosteller, John Tukey, and Charles Winsor

Physical Research Department, Bell Telephone Laboratories,
Department of Social Relations, Harvard University;
Department of Mathematics, Princeton University; and
Department of Biostatistics of the School of Hygiene and Public Health,
The Johns Hopkins University

THE COMPLEXITIES OF MODERN SCIENCE and modern society have created a need for *scientific generalists,* for men trained in many fields of science. To educate such men efficiently would require modified courses and new ones. However, a good beginning can be made now with courses which are available in many colleges and universities. One such program is set forth here.

General Considerations

The central problem. Scientific and technological advances have made the world we live in complex and hard to understand. We have today large scale division of labor, complex and indirect methods of production and distribution, large communities and large areas held together by common channels of transport and communication, and operation with small margins of safety, requiring close and delicate control. All these complex and delicate activities produce scientific and technological problems of great difficulty.

Science itself shows the same growing complexity. We often hear that "one man can no longer cover a broad enough field" and that "there is too much narrow specialization." And yet these complexities must be met—and resolved. At all levels, decisions must be made which involve consideration of more than a single field.

These difficulties are most pressing in the borderline fields like physical chemistry, chemical physics, biophysics, biochemistry, high polymers, and the application of chemistry, physics, and mathematics to medicine. It is here that both the challenge of the problems and the difficulties arising from over-specialization are greatest. We need a simpler, more unified approach to scientific problems, we need men who can practice science—not a particular science—in a word, we need scientific generalists.

Research teams, aggregations of men of diverse skills working on the various aspects of single problems, have been widely used and have accomplished much. Their use is certain to continue and expand. But the research team must have a leader to unify the group, whether he be director, coordinator, or advisor. This leader must work as a scientific generalist, and we feel he would function better if trained with this in mind.

There is a clear remedy for these complexities, both in education and in science, but its use will involve work and time. We must use the methods of description and model-construction which, in the individual sciences, have made the partial syntheses we call organic chemistry, sensory psychology, and cultural anthropology. We must use these methods on the sciences collectively so that, eventually, one can learn *science,* and not *sciences.*

We suggest that an attempt to unify science may reasonably start from the following ideas:

1. All science began as part of "natural philosophy" and radiated outward. (Even in this modern day, it should be possible to recapture the universalist spirit of the early natural philosophers.)
2. Scientific method is common to all sciences. (The difficulty that almost all scientists have in defining scientific method does not lessen the importance of this fact.)
3. Almost every science is more easily taught by using some of the equipment of the others. (This is generally admitted to be true for mathematics in physics, less generally for chemistry and physics in biology, to name two examples.)
4. Statistics, as the doctrine of planning experiments and observations and of interpreting data, has a common relation to all sciences.
5. Unification will be more easily attained if the logical framework of the individual sciences can be identified and isolated from their factual content.

The isolation of the logical framework of the sciences is a long overdue first step toward a synthesis of science. What is the logical framework of organic chemistry? Or equivalently, what are the characteristic ways in which a good organic chemist thinks and works? There is no place where a student can learn this directly, no place where it is set forth clearly, freed of as many detailed facts as possible. A second step would be the development of courses within individual sciences which really make use of the material and equipment from the other sciences.

A synthesis unifying the sciences is, at best, a long and difficult task. It is a problem that will take time to solve and we do not have a facile answer to it. We shall consider ways in which potential scientific generalists might, as undergraduates, be given the kind of background that would enable them to develop into real scientific generalists. Ours is frankly only an interim proposal; it makes no real synthesis. Yet, since the student will go deeply into parts of many sciences, he will learn something of the habits of mind of the chemist, psychologist, and geologist. These habits, and not subject matter, are what distinguish the sciences—for how else can we distinguish the chemical physicist from the physical chemist, the mathematical biologist from the biomathematician!

RELATION TO OTHER PROGRAMS

Generalists and scientific generalists. By confining ourselves to scientific generalists, we do not intend to undervalue the need of true generalists, trained in all disciplines, science among them. Science should be able to look to such true generalists for considered judgment about the fields where the greatest speed of development is needed, and then to the scientific generalist for help in attaining that speed. Acting alone, scientists are not competent to plan the training of the true generalists, so that, in spite of the great need of such men, it would be inappropriate for us here to attempt to lay out a program for their training. Nonetheless, some aspects of the scientific generalist's training bear on theirs.

Liberal education. We do not believe that a satisfactory synthesis of the modern world can be achieved without incorporating within it science and the scientific method, which have had a major share in shaping that world, and are still forcing the pace of change. First, however, we must develop some satisfactory synthesis of science by itself, else how can we hope for the greater synthesis of a liberal education, in which science plays so large a part?

Moreover, it seems clear that scientific methods of description and model-building are in many ways the most efficient intellectual techniques yet devised for covering a broad field quickly. Since any satisfactory program of liberal education involves covering an immense mass of material in a limited time, the most efficient techniques must be used. We lay stress in the generalist's education upon these techniques, and in particular upon taking advantage of the efficiency to be gained by using in each science some of the equipment of other sciences. We feel that similar efficiency *could* be gained in history, philosophy, and the "nonscientific" fields by using these techniques. We are not historians or philosophers. We can only say that we think historians and philosophers who are also scientific generalists seem most likely to begin this task.

Finally, we believe that while the scientific generalist's education is not intended primarily as a general liberal education, it may be a temporary approximation to one. The program we outline has room for enough nonscientific courses to meet the going minimum standards of a liberal education as well as the program for a scientific specialist does today. A true generalist would, of course, require a much broader program. In spite of this, a college graduate with an education based upon the generalist's program might well be a better lawyer, businessman, or teacher of high school science than one with a classic liberal education or one with specialized training in a single field.

THE SCIENTIFIC GENERALIST

What is he? By a generalist—and we shall not bother to specify every time that we mean scientific generalist—we mean a man with training and a working sense in many fields of physical and biological science. His principal interests may be broad or sharply defined, but he is exceptional in his breadth of appreciation. He may be working in pure science, or in the application of science to engineering, business, or industry. He may not be as good a physicist as a student or research man who has been trained principally in physics, or as good a geneticist as the biologist who is trained in genetics, or as good an economist or engineer or psychologist as a specialist in those fields. But he has learned enough of these fields, and of the central tools of mathematics and statistics, to bring to problems of almost any kind the ideas and broad tools of any combination of these many subjects that will speed and improve the work.

We are interested here in the education of a generalist during his four undergraduate years. These four years will not complete his education, any more than four years complete the education of a chemist, a psychologist, or an economist. After these undergraduate years, the budding generalist will go on with further study, presumably in some special field. The aim of the four undergraduate years is to give him a broad foundation and to open his mind to a wide range of scientific fields. Eventually, perhaps, there will be graduate training as a generalist, but until that day comes, specialized graduate study must serve.

Who needs him? First, any research group needs a generalist, whether it is an institutional group in a university or a foundation, or an industrial group working directly on industrial problems. If the problems are broad enough to require a group instead of a few isolated researchers, then there will be a place for a generalist. Many groups who now have generalists or near generalists do not recognize them as such, but think of them in terms of their specialties.

In addition, any first-class administrator or policy-maker in fields related to science must be a generalist to a considerable degree, if only to foresee external influences which might rock the boat. For example, the production of plastics has radically affected almost all enterprises based on the manufacture of small intricate parts. A good administrator needs a generalist's background in appraising the possible effects of going research, estimating its time of fruition, and judging the date and intensity of its ultimate impact on his organization.

What would he do? Many illustrations of the contributions a generalist can make to a research group can be drawn from the recent war. The ability to isolate critical elements, to establish the essentials of the logical framework, to reduce the problem to a few critical issues, is essential in handling problems of military engineering and operations analysis; it is also the ability that the scientist uses every day in his own work. The scientists who were able to carry over and apply their methods of thought to other fields were able to assist largely in the solution of military problems. By working as generalists these scientists distinguished themselves from the specialists, who found themselves baffled and uncomfortable when confronted with unfamiliar and ill-defined issues.

The problems of social engineering and economic engineering are similar to those of military engineering in their need for immediate action, their confusing variety of aspects, the lack of definition of their issues, and, often, the lack of basic knowledge appropriate to their solution. It seems not too much to hope that scientific generalists, amateur and professional, can do much toward developing these fields and solving many pressing problems.

In an engineering group the generalist would naturally be concerned with systems problems. These problems arise whenever parts are made into a balanced whole—balanced so as to serve an end efficiently. It may be weights that are balanced, or sizes, or complexities of component pieces of mechanism, or expense, effort, or research time applied to different phases of the problem.

In the social sciences, the generalist would provide background in physical science and in scientific inference, and experience in the analysis of data and in use of mathematical methods and techniques, which together seem essential for that rapid development of social science which we all agree is now so urgently needed. The generalist would assist in the construction, interpretation, and modification of mathematical models. He would examine previous findings from a fresh viewpoint. The generalist would be able to assist in the design of experiments—still a fairly weak spot in most of the social sciences. Incidentally, he would assist in the development of statistics by disclosing unsolved problems.

In biological and medical science he would provide efficient interpretation of data and design of experiment, and—what is most important—would suggest physical explanations or mathematical models for known or conjectured facts. The need of such useful and stimulating people is probably better recognized in this field than in any other that we know.

And finally, a student equipped with the undergraduate training of a generalist would have an ideal start toward becoming a consulting statistician, who must work with others on problems in many fields of science and technology. With this foundation, a graduate training in mathematical and theoretical statistics would produce the best beginning of a consulting statistician that we can plan today.

What is his background? Most of the small number of generalists that any institution might train during a year are, we think, going to have the following characteristics: They will be planning, definitely or tentatively, to go on to graduate study in some field. They will have interest and skill in science, fairly general and unspecialized. They will have met and mastered competition in high school (or preparatory school) and will have the self-confidence to attempt an unusual and challenging course in college. They will want to learn, and will be prepared to work hard. After a broad introduction to science, and after they have learned what the various fields of science are really like, and how the practitioners of these fields think and work, they will be able to make an intelligent choice between (1) some single field of science, (2) some borderline field between two or three sciences, and (3) the profession of being a generalist.

EDUCATING THE GENERALIST NOW

Principles. There are certain principles that must govern any plan for educating a generalist—an interim plan using present-day courses or the efficient plan of the distant future. Some of these principles are general and will offend no one; others are specific and will bother some administrators and some scientists. Let us list three:

1. The pregeneralist must study many fields of science deeply enough to understand their logical frame-

work and the approaches of their practitioners.

2. With the possible exception of a few tool subjects, the interest of the pregeneralist in factual information is definitely secondary.

3. Skipping prerequisites is to be encouraged.

The idea of skipping prerequisites may seem strange and shocking, but the generalist as such will always be working on problems for which he has not had the normal training. He needs to learn to work well under these adverse circumstances during his college years if he is to prepare for his job realistically. Such flexibility will make administrative complications, and will produce temporary discomfort for many instructors.

Program. We now give an illustrative program, which is specific enough about individual courses to make these principles explicit:

ASSIGNMENT OF 40 SEMESTER COURSES

Biology	4	Statistics	4
Chemistry	4 or 5	English	2
Geology	1	Industrial processes	1*
Mathematics	6	Judging	1*
Physics	6	Surveying	1
Psychology	2	Distribution	8 or 7

* If these special courses are not available, the time freed is to be applied to independent work or to distribution.

SUMMER WORK

1st: Summer surveying course listed above.

2nd: Completion of the language requirement of a broad reading knowledge in two important scientific languages (if possible by foreign study this summer).

3rd: Work on a research or development project involving real engineering problems.

INDEPENDENT WORK

Junior Year: Topic involving economic considerations.

Senior Year: Topic involving at least two fields and preferably three.

This program is a definite overload, since it combines 40 semester courses with independent work. But the pregeneralist must be an unusual student, building on high precollege attainment. Any student who does not understand what he has studied will be useless as a generalist, and will have achieved a "smattering of ignorance." Since most schools allow students to limp along with low grades, the pregeneralist's standing must be a full grade higher than that required in other programs.

Besides carrying out his formal program, the pregeneralist should meet regularly with sympathetic and active graduate students and faculty members, for lunch, perhaps, or to drink beer.

The regular courses. We take first the bulk of the program, reserving the special courses in English, industrial processes, and judging for a separate discussion.

The "distribution" courses will have real value for the generalist. History, philosophy, economics, the humanities, and the social sciences come here. Some educators might emphasize the need for a course in social change and cultural lag, others would put the emphasis elsewhere. We cannot plan these distribution courses now; their planning should involve all departments, and should probably not be too rigid.

Next come the courses in various fields of science. While specific courses are stated, *it is always permissible to replace any course by a more advanced course in the same field.*

In biology, where we include paleontology, paleobotany, physiological psychology, and the like, there are to be four courses. What shall they be? We do not feel prepared to make really detailed suggestions, and can only point out that it is essential that not all of the courses be at the elementary or near elementary level. It has been suggested by one of our friends (K. W. Cooper) that if four semesters of work in biology were to be given to such students, the most desirable plan might be: (1) cellular biology or general physiology (from the viewpoint of transfer of energy, intermediary metabolism, physiology), (2) comparative anatomy (from the developmental and truly comparative point of view), (3) the problems of genetics (persistence and change of hereditary patterns), and (4) evolution and the evolutionary record. If such a program were available at any institution, we would gladly recommend it as one good set of four courses for the training of a generalist.

The four or five courses in chemistry we propose must give the future generalist a bird's-eye view of a broad field. Hence, we advocate a large amount of skipping around: one or two semester courses in elementary chemistry, one semester in organic chemistry, one semester in physical chemistry, and one semester or none in an advanced elective. To the chemist, the idea of taking one semester of organic chemistry and then jumping to one semester of physical chemistry may seem strange, wild, and unwarranted. But the student generalist wishes to learn how a chemist thinks, how problems are approached, and in what general direction he may learn things once they seem necessary or useful in a particular problem. One semester of organic chemistry (whatever classes of compounds are discussed) and one semester of physical chemistry (whatever branches are included) will do much to orient him and give him a basis on which he can build later as needed. He will know enough physics and mathematics to learn physical chemistry.

Only one course is listed in the field of geology, since paleontology, paleobotany, and the like were included under biology. Just which course is to be taken can safely be left to the choice of the student.

In mathematics there are standard courses available: four semester courses or less in elementary mathematics through calculus and differential equations, one semester in complex variables, and one or more semesters of advanced electives. These courses seem to need little comment.

In physics (where we include astronomy) the situation is also simple, for the courses which should be taken are available at most institutions. Here we suggest: two semester courses in elementary physics, one or two semesters in electricity (circuits and waves), one semester in physical measurements, and one or two semesters of advanced electives. We feel that a knowledge of electrical circuits and the associated knowledge of the uses and behavior of electron tubes would be an essential tool for a generalist in almost all the fields that interested him. The other courses seem to us to require little explanation.

Two courses are proposed in psychology: one semester course in experimental psychology, and one in systematic psychology. Experimental psychology will include laboratory work. Systematic psychology will be a study of psychological problems and theories, with some emphasis on methodology and classic experiments. It will provide a theoretical interpretation for the experimental course. Here the essentials seem to be (1) learning how the psychologist approaches his problems, and (2) acquiring an appreciation of the complications and difficulties which the human observer always introduces into any experiment or study.

In statistics we propose four semester courses, which can probably be found at a few institutions where the training in statistics has been well organized and developed: one or two semester courses in elementary mathematical statistics, one semester in design and analysis of experiment with practical work, and one or two semesters in advanced mathematical statistics, including multivariate methods and the use of order statistics. Because statistics is one of the main tools for applying the quantitative method to any field of science, we feel that four semester courses are by no means too many. We feel that statistics is a distinct field, rather than a branch of mathematics under a new name.

English has been allotted two semester courses in composition. These should be, primarily, courses in exposition. We should prefer to have one a freshman course in "How to Say What You Mean," orally and in writing. The other should be a junior or senior course in writing technical reports, papers, and expository accounts, with emphasis on getting the results and essential spirit across to nontechnical readers.

The proposed inclusion of a course in surveying in this curriculum has led to considerable discussion, and it seems worth while to make very clear what values we hope might be obtained from it, particularly if it were taken just before the beginning of the freshman year. It would provide students with experience in physical measurements for which there are checks (the traverse must "close"), and give them opportunity to observe the customary processes of handling data. It is not essential that the student become a good surveyor, but it is very much to his advantage to learn to recognize a man who is good with tools, and good at measuring.

The special courses. There are two courses that we think should be added to present offerings in order to improve the interim training of the generalist. The first could be given tomorrow at many institutions. The other, here somewhat obscurely entitled "judging," would be very difficult for anyone to teach.

The course in industrial and shop processes should summarize how things are actually made. It could be entirely descriptive, since it is to train generalists, not engineers, and therefore one semester would suffice. It should, for example, describe forging and milling, the function of a turret lathe, the kinds of heat treating used and their effects, what an industrial still looks like, and how it operates—in other words, teach him the unit operations of mechanical, electrical, and chemical engineering. The generalist needs some knowledge of how materials are manipulated.

Somewhere in the curriculum, probably in the senior year, there should be a course in judging, guessing, and the scientific method. This course is needed not only by the generalist, but by many other scientists. We have no way now to encourage or require a man to bring his education and intelligence to bear on estimation and prediction problems for which he has inadequate information. As a result, scientists often become stuffy and narrow in their views. To meet this need, we propose a course in educated, intelligent guessing. It would be principally a laboratory course, in which essentially impossible problems were put to the student, who would be required to supply answers and estimates of their trustworthiness, on the basis of the inadequate data given plus what he knows about the world. The time limits for these answers would vary. Some problems would be done by individuals; others by groups. There would be discussion periods after solutions were submitted. The main difficulty with this course would be finding an instructor equipped to teach it.

None of these four special courses is essential to the training of a generalist, but all of them would be extremely helpful. We believe their value to other students as well as to generalists would make them worth adding to the offerings of most colleges.

Another generally useful course which we would place next in importance for the pregeneralist is one in "intellectual techniques." This should supply the student with tools which would help him to ingest and digest a large amount of material in a limited time. It should include rapid and effective reading, quick ways of using a library, and what is known about efficient methods of study and learning. Such a course should come in the freshman year if possible. Some of us feel that introductory psychology is a good facsimile, others feel that it does not concentrate enough on the tool aspect to meet the need.

Installing the program. Before any new program can be introduced into an American college or university without objection it must be shown to fill certain needs. For the next decade colleges will ask: Does this program meet the distribution requirements? Does this program fit into the scheme of departmental concentration or majoring?

Distribution requirements vary from institution to institution, and are in the process of changing at many institutions. We have compared the proposed program with the distribution requirements at Harvard and at Princeton, since we are most familiar with these universities. There the distribution requirements would easily be met. It seems reasonable to conclude that this program would be consistent with the distribution requirements of a substantial number of institutions.

Next, there must be a home for the pregeneralist. Some department must be prepared to accept his widely distributed work as concentration in that department. Or a new interdepartmental program must be set up! Fnding a home may be difficult.

There will be difficulty with individual scientific departments wherever such a program is proposed; each such department has a natural desire to have these very good students concentrate in its department.

Finally, there will be objections from administrators about any program requiring students to take courses without the usual prerequisites.

These difficulties of installation, however, are merely details, and such a program can be started.

The point of view we have tried to expound might be summarized thus: Science is complex; yet it must become manageable. It can be managed better with the help of a few scientists with training in many sciences. A few such scientific generalists can be trained tomorrow with the courses at hand. To make science more manageable, we must perform a new and difficult synthesis on a higher level of organization.

Photoproduction of Molecular Hydrogen by *Rhodospirillum rubrum*

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THE PHOTOSYNTHETIC, nonsulfur purple bacterium, *Rhodospirillum rubrum* (strain SI)[2] will grow anaerobically upon illumination in a synthetic medium consisting of pure organic substrates, mineral salts including ammonium chloride, and a trace of biotin (*3*).[3] The organic substrate can be any of a large variety of compounds. Substrates more oxidized than carbohydrate are decomposed with a net production of CO_2 during growth. Aside from CO_2 and cell material, no other products have been observed in appreciable quantity. However, *R. rubrum* grown photosynthetically on certain oxidized substrates, with glutamate or aspartate instead of ammonia as a nitrogen source, exhibits in addition to CO_2 evolution a vigorous production of hydrogen.

In a preliminary survey, the only compounds so far found to be effective in evoking hydrogen production in growing cultures are malic, fumaric, and succinic acids. Of several dozen substrates tested at pH 6.6 with resting cells derived from hydrogen-producing cultures, only malic, fumaric, oxaloacetic, and pyruvic acids are effective. The magnitude of the hydrogen evolution from malic acid is of the order of one mole per mole of added substrate. Succinic acid has been tested with resting cells using pH values varying from 5.7 to 8 because of the discrepancy in response of resting cells and of growing cells to this substance. Although extensive CO_2 evolution is observed over most of this range, no H_2 evolution is noted with succinic acid as substrate. This point is being investigated further.

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[1] Predoctoral fellow of the American Cancer Society, recommended by the Committee on Growth of the National Research Council, 1947–1949. Present address, Department of Microbiology, Western Reserve University Medical School, Cleveland, Ohio.

[2] Original culture obtained through the courtesy of Prof. C. B. van Niel, Hopkins Marine Station, Pacific Grove, California.

[3] Hutner studied growth under aerobic conditions only. However, it appears that anaerobic growth requirements are similar.

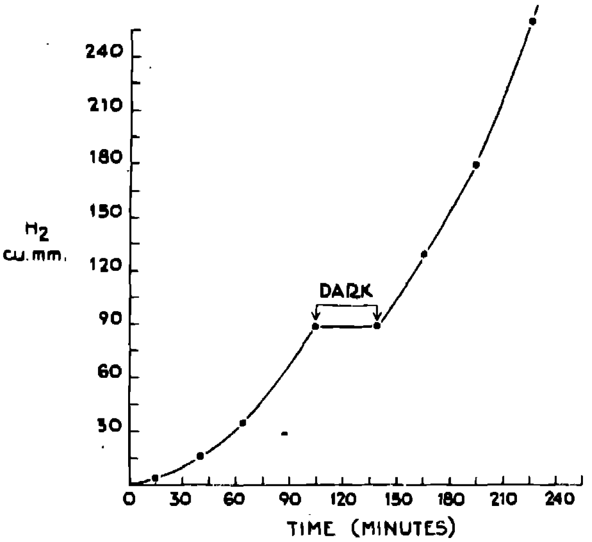

FIG. 1. Photochemical production of H_2 by *Rhodospirillum rubrum* (SI): 50 mm³ of washed cells was suspended in 2 ml M/20 phosphate buffer (pH 6.6) and 5 mg of D,L-malate was tipped in at zero time. The center well contained 0.2 ml of 10% KOH; the gas space was filled with 100% helium.

When the gas phase in resting cell experiments is helium, argon, or hydrogen, a vigorous photoproduction of molecular H_2 is observed. A typical experiment is shown in Fig. 1, which demonstrates the results obtained with conditions as noted in the legend. In the presence of nitrogen there is no evolution of H_2. The possibility that a slight oxygen contamination of the nitrogen is responsible for the inhibition has been eliminated in three ways. First, a gas mixture consisting of 1 percent oxygen plus 99 percent helium fails to repress H_2 production. Second, nitrogen completely freed of oxygen (99.99 percent N_2) inhibits H_2 evolution. Third, a mixture of pure nitrogen (0.1 atmosphere) and helium (0.9 atmosphere) inhibits H_2 production. In addition it has been found that ammonia abolishes H_2 production under helium or hydrogen. Thus H_2 production is not observed if ammonium salts or molecular nitrogen are present. This effect of ammonia brings to mind nitrogen-fixing organisms, in which combined nitrogen inhibits production and activity of hydrogenase (*4*). The possibility exists that there may also be a hitherto unsuspected nitrogenase system in *R. rubrum*. This is now being investigated, using molecular nitrogen labeled isotopically.

The production of hydrogen during normal photosynthesis by either growing or resting cells of *R. rubrum* is unusual in that there is always present a large amount of CO_2 which can be reduced with hydrogen photochemically by these organisms, as can be demonstrated with resting cells.

Hydrogen evolution is dependent on exogenous substrate, is not inhibited at high light intensity, and does not require a prolonged adaptation period. Thus, photoproduction of hydrogen by *R. rubrum* differs from the only instance of photoproduction of hydrogen reported previously. Gaffron and Rubin (*2*) observed that in the green alga, *Scenedesmus*, an endogenous production of hydrogen of low magnitude occurred at low light intensity after long anaerobic incubation of these ordinarily aerobic organisms in the absence of CO_2, or in the presence of CO_2 when dinitrophenol was added. There is also to be remarked as a point of difference the unexpected effect of molecular nitrogen in inhibiting the H_2 evolution noted in *R. rubrum*.

Attempts to link hydrogen evolution to a formic hydrogenlyase system have failed. Growth in the presence of formate produces organisms which will evolve hydrogen in the dark with formate as substrate and with N_2 as the gas phase. However, no photoproduction of H_2 has been observed with formate. It may be recalled that fermentative production of H_2 by microorganisms is ordinarily inhibited by H_2 (*1*), whereas this is not the case with *R. rubrum*.

The data at hand do not permit of a decision as to the source of the photohydrogen. As a working hypothesis, it may be assumed that the substrate employed is the source, on the basis of the substrate specificity observed. The possibility of testing this hypothesis using labeled hydrogen is remote but is being considered.

In conclusion, it appears that *Rhodospirillum rubrum* under the influence of light and in the presence of a single organic substrate can liberate hydrogen as a photosynthetic product. This hydrogen evolution is linked to nitrogen metabolism and perhaps even to a nitrogenase system. It is hoped that further work now in progress with labeled nitrogen, hydrogen, and carbon will clarify the mechanisms involved in this production of molecular hydrogen during hydrogen transfer in photosynthesis.

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Evidence for a Nitrogenase System in the Photosynthetic Bacterium *Rhodospirillum rubrum*

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IT HAS BEEN DEMONSTRATED that the nonsulfur purple bacterium, *Rhodospirillum rubrum* (strain SI) will produce molecular hydrogen as a major photosynthetic product during illumination in certain media (*1*). This phenomenon does not occur when nitrogen is present either in the elementary form or as ammonium ion (*1*). These observations suggest the existence in these organisms of a nitrogenase or nitrogen-fixing system, hitherto unsuspected.

Evidence has been obtained using molecular nitrogen labeled isotopically with N^{15} which appears to provide unequivocal support for the existence of a light-stimulated nitrogenase system in *Rhodospirillum*. In one set of experiments, 3-day-old H_2-producing organisms were harvested by centrifugation, washed twice with *m*/20 phosphate buffer (pH 7.2) and suspended in a neutral medium containing $MgSO_4$, phosphate buffer, trace elements, biotin and D,L-malic acid. The bacterial suspension was divided into three 10-ml portions. Two portions were placed in 75-cc Warburg vessels on a vacuum line. The third portion was boiled and the dead organisms so obtained were placed in the third vessel on the vacuum line to provide a control. After evacuating and flushing the vessels and vacuum system several times with helium, the vessels were filled to 0.1 atmosphere with labeled N_2 (30% N^{15}) and 0.9 atmosphere helium. The nitrogen was generated from Eastman Kodak NH_4NO_3 (30% N^{15} in the NH_4 group) with alkaline NaOBr and freed of all combined labeled nitrogen (NH_3 or N oxides) by passage through two liquid air traps. Control experiments revealed no detectable NH_3 in the elementary nitrogen ($< 2 \times 10^{-3}$ mg NH_3 in a total of 6 mg as N_2). One vessel was illuminated, one was kept in the dark. After 6 days, the organisms were separated, and total Kjeldahl nitrogens obtained. These were analyzed for N^{15} content.[2] The organisms maintained in the light showed an N^{15} content in total cellular nitrogen of 3.14 atom percent excess; those in the dark, 0.189 atom percent excess; and the boiled controls 0.008 atom percent excess. In another set of experiments almost identical results were obtained with the additional observation that small amounts of ammonia (0.5 mg NH_4Cl/ml) inhibited N^{15} uptake from the labeled molecular nitrogen.

These observations appear to be the first reported in which there have been demonstrated (1) a nitrogenase system in photosynthetic bacteria, (2) a specific effect of molecular nitrogen on hydrogenase activity, and (3) a stimulating effect of light on turnover of molecular nitrogen. These observations have been confirmed in the laboratories of R. H. Burris and P. W. Wilson at the University of Wisconsin. We wish to express our appreciation for their wholehearted cooperation.

It has been ascertained that the N^{15} uptake observed is the result of a net fixation of nitrogen. An illuminated suspension of *R. rubrum* maintained for 30 days in an atmosphere of molecular nitrogen and hydrogen and in a medium devoid of all combined nitrogen except for a minimal quantity of yeast extract has shown a seven-fold increase in cellular nitrogen gained at the expense of molecular nitrogen.

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[1] Predoctoral fellow of the American Cancer Society, recommended by the Committee on Growth of the National Research Council, 1947–1949. Present address, Department of Microbiology, Western Reserve University Medical School, Cleveland, Ohio.

[2] We are indebted to Prof. D. Rittenberg and Mr. I. Sucher, Columbia University, and to Dr. Mildred Cohn, of Washington University, for the N^{15} analyses.

A Microorganism Exhibiting a Growth Requirement for Peptides[1]

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IN SEVERAL RECENT PUBLICATIONS (*2, 3, 4*), data have been presented concerning the relative growth-promoting action of amino acids and peptides for appropriate mutant strains of *Escherichia coli*. In the case of one mutant, a *prolineless* strain, better growth was obtained in a medium containing L-proline peptides than in a medium containing an equimolar concentration of L-proline (*3*). While this enhanced growth-promoting activity of the proline peptides may be due to their direct incorporation into the bacterial proteins, other possible explanations cannot be excluded. Thus, it may be that, in the course of the bacterial growth, a portion of the free proline is converted to products that are not growth factors for the mutant, and that this conversion is prevented by the linkage of the proline residue in a peptide. Also, the possibility must be considered that the presence of proline in peptide linkage aids more directly in the incorporation of this amino acid in the bacterial proteins, perhaps by "transpeptidation" reactions. Whatever the correct explanation turns out to be in the case of the *prolineless* mutant, it may be expected that the closer study of this and other bacterial strains that exhibit characteristic growth requirements for peptides of well-defined structure will throw valuable light on the metabolism of peptides in living systems.

In the present communication, the authors wish to report preliminary studies on a microorganism which, under specific experimental conditions, grows in the presence of the dipeptide L-leucylglycine, but does not grow in the presence of a mixture of L-leucine and glycine, and grows only poorly in the presence of L-leucine. This microorganism was obtained from an unsterilized solution of L-leucylglycine in 0.9-percent NaCl which had been kept at room temperature for several weeks.[2] When a loopful of the turbid dipeptide solution was plated out on nutrient agar, only a

TABLE 1

GROWTH RESPONSES OF BACTERIAL STRAIN SF

Test compound	Growth* in saline			Growth* in saline-glucose		
	48 hr	72 hr	96 hr	48 hr	72 hr	96 hr
L-Leucine	0.009	0.020	0.026	0.032	0.027	0.018
D-Leucine	—	—	—	—	—	—
DL-Leucine	—	—	—	—	—	—
L-Leucylglycine	0.065	0.122	0.146	0.060	0.127	0.130
L-Leucine + glycine	—	—	—	—	—	—
D-Leucylglycine	0.004	0.004	0.004	—	0.002	0.006
L-Leucylglycylglycine				0.032	0.071	0.131
L-Leucylglycine + glycine	—	—	—	—	—	—
Glycyl-L-leucine	—	—	0.002	0.018	0.028	0.027
Glycyl-L-leucine + glycine	—	—	—	—	—	—
Acetyl-L-leucine†	—	—	—	—	—	—
L-Phenylalanylglycine				—	—	—
L-Phenylalanine	—	—	—	0.017	0.021	0.015
L-Phenylalanine + glycine				—	—	—
Glycylglycine	—	—	—	—	—	—
Glycine	—	—	—	—	—	—
L-Asparagine	—	—	—			
L-Alanine	—	0.062	0.080	0.082	0.041	0.042
L-Glutamic acid†	0.052	0.007	0.072	0.029	0.039	0.044
L-Isoleucine	—	—	—	—	0.012	0.018
L-Valine	0.148	0.213	0.228	0.110	0.098	0.069
NH_4Cl†				0.012	0.014	0.009
NH_4Cl† + glycine	—	—	—	—	—	—

* The extent of bacterial growth is recorded as the optical density of the culture, where density = 2 − log galvanometer reading. A dash indicates the absence of measurable growth.

† Neutralized with NaOH before use.

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[1] This study was aided by a grant from the Rockefeller Foundation.

[2] The authors wish to express their thanks to Dr. Henry D. Hoberman, in whose laboratory the peptide solution was kept, and who kindly called our attention to the bacterial growth in the solution.

single type of colony appeared after 24 hours at 30°. A subculture of one of these colonies served as the source of the organisms used in the tests reported below. For convenience, the isolated bacterial strain will be termed "SF."

Examination of the isolate showed it to be a short, nonmotile rod which is Gram-negative and occurs singly or in pairs in Gram-stained preparations.[3] In nutrient broth containing glucose, lactose, or sucrose, it does not cause the formation of acid or gas; after 3 days, such test solutions have a pH of 8 or higher. It turns litmus milk alkaline and liquefies gelatin. The organism has been tentatively classified, therefore, as a member of the genus *Alcaligenes*.

The ability of strain SF to grow in saline solutions containing a variety of amino acids or peptides is shown in Table 1. In performing the tests, Evelyn colorimeter tubes, containing 8 cc of the test medium, were incubated at 30°, and the extent of bacterial growth was measured at intervals in an Evelyn colorimeter with filter No. 540. As is indicated in the table, one series of tests was conducted in the presence of amino acids or peptides as the sole source of carbon and nitrogen in the medium, while in a second series glucose was added as an additional potential source of carbon. When 0.9-percent NaCl alone was used as the medium, the concentration of each test substance was 0.1 M; when saline was supplemented with glucose (0.17 M), the concentration of the test substances was lowered to 0.05 M. The inocula for the tests consisted of a drop of an aqueous suspension of cells taken from a peptone-yeast extract-agar slant which had been incubated for 24 hours at 30°. Under these conditions, visible growth was not evident until 24 hours after inoculation, and significant readings with the Evelyn colorimeter were not obtained until 36–48 hours after inoculation.

The data in Table 1 show that strain SF grew equally well when L-leucylglycine was present in the medium in combination with glucose or when the peptide represented the sole carbon source for growth. No growth was noted when L-leucine and glycine were present, and the presence of L-leucine promoted the growth only slightly. It was observed that, in every case in which it was tested, glycine exerted an inhibitory effect upon the growth of strain SF. It would appear, however, that glycine is not bactericidal, since the same number of viable cells could be recovered, after 5 days' incubation, from a medium containing glycine as from a medium containing DL-leucine, in neither of which was there any visible growth. The complete failure of strain SF to grow in the presence of DL-leucine suggests that the D-isomer may act as a growth inhibitor. It is also of interest that, with D-leucylglycine, there was noted only slight growth, which may be due to the presence of a small amount of the L-form of the peptide in the commercial preparation used for these experiments.

L-Leucylglycylglycine produced a growth response similar to that noted with L-leucylglycine. Glycyl-L-leucine and acetyl-L-leucine, however, showed little, if any, growth-promoting activity. It would appear, therefore, that significant growth of strain SF in the presence of leucine peptides is favored only when the L-leucine residue is present at the amino end of an unsubstituted peptide. When the L leucine residue in L-leucylglycine was replaced by that of L-phenylalanine or of glycine, the resulting L-phenylalanylglycine or glycylglycine was inactive in promoting bacterial growth. Although further studies of the specificity of the peptide requirements of strain SF are necessary, it may be concluded from the above results that the presence in the medium of a dipeptide *per se* does not satisfy the growth requirement.

The data in Table 1 show that the organism does not have a specific requirement for leucyl peptides since L-alanine and L-glutamic acid permitted fair growth and L-valine served as a better growth factor than even L-leucylglycine. On the other hand, L-asparagine did not promote bacterial growth, and a medium containing NaCl, NH_4Cl, and glucose gave only a slight growth response. However, other tests in which the basal medium usually employed by us for *Escherichia coli* (i.e., a mixture of inorganic salts, including NH_4Cl and NH_4NO_3, glucose, and a small amount of asparagine (*1*) was used, showed that strain SF is capable of growth when glucose is the source of carbon, and ammonia and nitrate are the principal sources of nitrogen. The addition of 0.1 mM of glycine per cc of this medium completely inhibited the growth of strain SF, while a concentration of 0.001 M glycine retarded growth appreciably.

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[3] The authors are indebted to Dr. C. F. Robinow for his valuable advice in the characterization of the bacterial strain.

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TECHNICAL PAPERS

Suppression of Gastric Acidity with Beta Particles of P^{32}

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Irradiation of the gastric mucosa by X-rays or gamma rays of radium has suppressed gastric acidity (*2, 3*). Such irradiation penetrates and affects not only the gastric mucosa, but also adjacent organs. The liver and small intestine are more sensitive than the gastric mucosa to radiation (*1*), and damage to these adjacent organs may occur if large doses of X-rays or gamma rays are directed to the stomach.

To suppress acidity, it would therefore seem more suitable to restrict radiation to the gastric mucosa. This is accomplished by the topical application to the mucosa of a radiation source emitting rays which are absorbed almost completely by the stomach. A suitable source is the radioactive isotope of phosphorus, atomic weight 32, for this isotope emits beta particles whose maximum range in tissue is about 8 mm. An applicator was devised to apply P^{32} topically to the mucosal lining of Heidenhain stomach pouches in dogs.

The applicator was a thin rubber bag inflated to a volume of 50 cc with air, sprayed with rubber cement, and covered with flocs of short cotton fibers, so that the covering resembled a smooth coat of felt. The inflated balloon was dipped into a solution containing P^{32} and allowed to dry. By a series of these dippings and dryings as much as 25 mc of P^{32} was adsorbed uniformly on the flocculate surface of the balloon. The balloon was then deflated, covered by a rubber condom, inserted into the Heidenhain pouch, and reinflated with air to its original volume of 50 cc. The condom covering the balloon prevented loss of P^{32} from the felt-like surface and only adsorbed 4% of the beta activity.

A series of control observations were made on the secretion of Heidenhain pouches with histamine as a stimulus. Then the pouches were irradiated.

After exposure to this beta radiation for periods of 2–6 hr the balloon was deflated and withdrawn. Subsequently, acid secretion tests were again made with the same stimulus of histamine used in control secretion observations. The pouch mucosa was observed by cystoscope, and multiple punch biopsies of the mucosa were made in some of the animals at frequent intervals.

The maximum thickness of the mucosa of these Heidenhain pouches is about 4 mm, and the average thickness is about 3 mm. At a depth of 3 mm the dose is about 25% of the dose in the first mm of mucosa. The thickness of the whole pouch wall is about 7–8 mm, at which depth the dose has decreased to less than 2% of the dose to the first mm of mucosa. Preliminary histological examination of a post-mortem specimen indicates that there is no discernible change in the serosa of the pouch when the mucosa has been heavily irradiated.

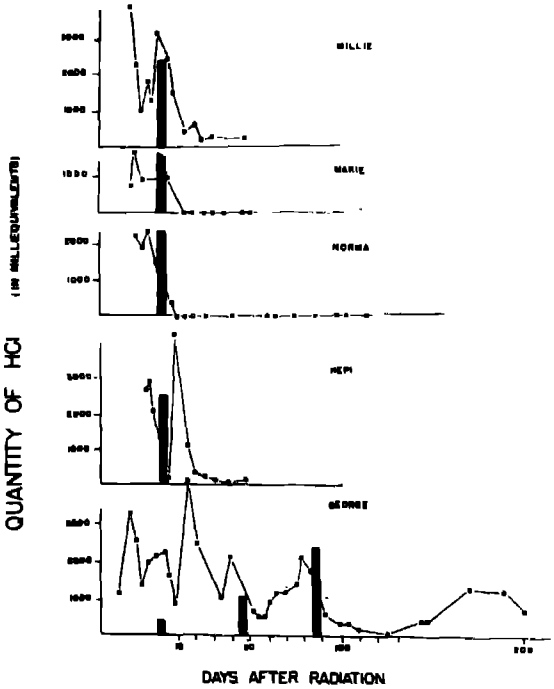

FIG. 1.

Radiation was followed after a few days by a decrease in total secretion as well as a decrease in quantity and concentration of HCl in the pouches of all five dogs studied. Two of these five dogs had anacid pouches, and the other three were hypoacid. Intubation of the stomach during the course of these secretion tests with histamine stimuli showed that the secretion of the true stomach had a pH of 1.0 at the same time the pouch secretion had a pH of 7.0.

Fig. 1 shows the change in pouch acid secretion after radiation. All radiation exposures yielded doses in the magnitude of 20,000 to 25,000 equivalent roentgens to the first mm of tissue except for the preliminary radiation on George (lowest graph in Fig. 1).

The heavy vertical bars in this instance represent respectively 1,800, 12,000 and 25,000 equivalent roentgens in the first mm of mucosa. Although the decrease in acidity with the lower doses was not apparent, the higher doses invariably decreased pouch acidity. All other vertical heavy bars in Fig. 1 represent radiation

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[1] Dazian Fellow in Radiology.

[2] The author gratefully acknowledges the assistance and cooperation of Franklin Hollander, Head, Gastroenterology Research Laboratory of the Mount Sinai Hospital.

exposure of 20,000 to 25,000 equivalent roentgens to the first mm of tissue. A few weeks after radiation, the quantity of acid secreted had decreased to levels ranging from anacidity to 10% of the quantity secreted before radiation. The longest period of observation after radiation in any animal was 125 days.

There were no changes in blood count, weight, or general condition of the animals which could be attributed to the radiation.

In summary, the gastric mucosa of Heidenhain pouches of five dogs was irradiated with beta particles of P^{32}, with a resultant marked decrease in the quantity of acid in the pouch secretion.

If similar techniques in humans are contemplated it is important to note that the dog Hepi had return of acidity in its Heidenhain pouch 3 months after irradiation. When the animal was sacrificed two weeks later, autopsy showed an ulcer of the pouch mucosa at the site of previous biopsy.

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β-Glucuronidase Activity

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During the past few months, a method has evolved which gives promise as a diagnostic aid in female genital carcinoma. Fishman (*1*) first reported an increased activity of the enzyme β-glucuronidase in carcinoma tissue (breast, esophagus, stomach, and colon). Subsequently (*2*), results from other malignant tissues were added to his series. The possibility of measuring the tissue activity of β-glucuronidase from the more accessible pelvic malignancies (vulva, vagina, and cervix) as a diagnostic aid is self-evident. Furthermore, if present indications prove correct, the vaginal fluid which bathes the cervix and vagina should become a rich source of this enzyme in the presence of a lower genital tract malignancy.

Accordingly, β-glucuronidase assays were made on the various genital tissues and on vaginal fluid for the purpose of establishing the range of activity in histologically benign lesions, and in carcinoma. Tissues were weighed, homogenized in water, and the centrifuged homogenates assayed, using phenolphthalein glucuronide as substrate, according to the method described by Fishman, Springer, and Brunetti (*3*). Using a pipette, 0.1-ml portions of vaginal fluid were suspended in 3 ml of distilled water or Tyrode's solution. Assays were made on both uncentrifuged specimens and on the centrifuged supernatants. Values were expressed as γ of phenolphthalein liberated per g of tissue or ml of vaginal fluid per hr. Our results are tabulated.

In the absence of pregnancy, the range of β-glucuronidase activity in those cervices without histological evidence of malignancy was from 23 to 330 γ of phenolphthalein per g tissue per hr (Table 1). The upper limit of this group was significantly less than the lowest value for cervical carcinoma, 543 γ, #299510 (Table 2).

TABLE 1

GLUCURONIDASE ACTIVITY

Tissue	Cases	γ of β-Glucuronidase*	
		Range	Average
Benign cervix	13	23– 330	142
Pregnant cervix	8	221– 591	384
Malignant cervix	6	543–2700	1274

* β-Glucuronidase expressed as γ phenolphthalein liberated per g of tissue per hr.

A variety of clinical and pathologic diagnoses were found among the benign cervices studied. Most were from cervical biopsies obtained to rule out malignancy. Others included senile vaginitis, cervical erosion, acute and chronic cervicitis, and some apparently normal organs. A histologic examination of the tissue adjacent to the area assayed established an absence of malignancy. The activity of b-glucuronidase in vaginal mucosa (nonpregnant) was similarly low. The enzyme activity of pregnant cervix (at term) was higher, and there was some overlapping with the malignant group. No explanation is offered at the present time for this finding.

TABLE 2

GLUCURONIDASE ACTIVITY OF UNTREATED CARCINOMA TISSUE

Identification	Microscopic diagnosis†	γ of β-Glucuronidase‡
430773	Sq. ca. cx.	934
438040	Sq. ca. cx.	2700
159341	Sq. ca. cx.	1634
452839	Sq. ca. cx.	847
299510	Sq. ca. cx.	543
45424	Sq. ca. cx.	897
A.M.*	Sq. ca. vag.	688
A.S.*	Sq. ca. vag.	680

* Patient at another hospital.

† Sq. ca. cx.—Squamous carcinoma of cervix; Sq. ca. vag.—squamous carcinoma of vagina.

‡ β-Glucuronidase expressed as γ phenolphthalein liberated per g of tissue per hr.

The malignant tissues studied are tabulated in Table 2. The range of activity was high. Two specimens of endometrial carcinoma were assayed. These measured 11,930 and 6,370 γ. The lower of these values is within the range of glucuronidase activity for endometrium in women with normal menstrual periods (895 to 9040 γ) (*4*) and both are well within the range for endometrium in patients with functional uterine bleeding (1,180 to 20,050 γ) (*5*). The activity of β-glucuronidase in normal ovary and in benign ovarian tumors varied greatly. It is our impression that the assay for tissue glucuronidase will prove of more value in lower genital tract carcinoma.

In the presence of untreated lower genital tract carcinoma, the vaginal secretion was uniformly high in glucuronidase activity, the lower range being 477 γ uncentrifuged (Table 3). It is apparent from studies on vaginal secretion obtained from women with benign lesions that false positive tests occurred (Table 4). These were obtained principally from patients who were pregnant and from patients with a trichomonas vaginitis. Following irradiation therapy for genital carcinoma, the vaginal fluid was less active (in the absence of a recurrence) than in the untreated group. This observation suggests the use of vaginal fluid assays as a method of follow-up. Results from the centrifuged supernatant fluid were generally lower than those of the uncentrifuged specimen. Thus, it may be inferred that more glucuronidase activity was associated with the solid (cellular) component of the suspension. It was found that the centrifuged supernatant fluid of suspensions in Tyrode's solution was less active than suspensions in distilled water. This is probably due to less laking of the cellular component in Tyrode's solution. These studies are being continued on a larger scale.

TABLE 3

GLUCURONIDASE ACTIVITY IN VAGINAL FLUID OF UNTREATED CARCINOMA

Identification	Microscopic diagnosis†	γ of β-Glucuronidase‡	
		Uncentrifuged	Centrifuged
432505	Sq. ca. cx.	1458 1368	
436773	Sq. ca. cx.	498	240
438049	Sq. ca. cx.	477	136
489485	Sq. ca. cx.	900	459
436773	Sq. ca. cx.	1335	1010
299510	Sq. ca. cx.	1412	962
140393	Endomet. Car.	1218	493
A.M.*	Sq. ca. vag.	883	
45424	Sq. ca. cx.	1980	665

* Patient from another hospital.

† Sq. ca. cx.—squamous carcinoma of cervix; endomet. car.—endometrial adenocarcinoma; sq. ca. vag.—squamous carcinoma of vagina.

‡ β-Glucuronidase expressed as γ of phenolphthalein liberated per ml of vaginal fluid per hr.

TABLE 4

GLUCURONIDASE IN VAGINAL FLUID OF BENIGN LESIONS

γ of β-Glucuronidase*	Number examined	
	Uncentrifuged	Centrifuged
over 501	4	1
301–500	8	2
101–300	8	5
51–100	11	2
1– 50	17	19
0	7	23
Total	50	42

* β-Glucuronidase expressed in a frequency table as γ of phenolphthalein liberated per ml of vaginal fluid per hr.

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The Nature of the Pigmented Sheath in *Drosophila* Tumors[1]

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In previous studies of tumors occurring in *Drosophila melanogaster* it has been noted that those in larvae several days old are surrounded by a pigmented coat, and appear as black, or brownish-black masses. In younger specimens, tumors, though present, lack the pigmented coat. It has been suggested by some workers (*2–4*) that the pigmented sheath is melanin, but this has not been substantiated by chemical tests.

The nature of the pigment is a matter of interest for several reasons. First, it seems to act as a limiting barrier against the growth of the tumor mass. Second, for detailed cytological study of tumors, it would be of great value if the pigment could be inhibited or delayed. Good cytological pictures may be obtained now only from tumors in quite young larvae.

Since melanin is the likeliest possibility in insect material, it was decided to test for it first, using two tests suggested by Cowdry (*1*). One is an oxidizing process employing $KMnO_4$ followed by oxalic acid; the other involves bleaching in the presence of concentrated NaOH.

Flies of tumorous strain "bw tu" were placed in half-pint containers, the caps of which held on their inner surfaces blocks of molasses agar seeded with yeast. The bottles were inverted and the flies could thus feed and deposit their eggs on the readily removable agar blocks. Caps were changed daily, the blocks each time being transferred to Petri dishes containing molasses agar well seeded with yeast. Here the eggs were allowed to hatch, and larvae to develop. Approximately 80–90 hr following transfer to the Petri dishes, tumerous larvae showed heavy deposits of pigment surrounding the neoplasms, and were considered ready for examination.

By flooding the Petri dishes with water, the larvae could be pipetted out and transferred to Syracuse watch glasses for microscopic study. Tumors were teased out with dissecting needles under broad field microscope and

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[1] The work reported here is part of a research project supported by a grant from the Cancer Research Grants Branch, Division of Research Grants and Fellowships, National Institutes of Health, Bethesda, Maryland.

transferred by means of a fine pipette to Stender dishes containing either concentrated NaOH or 0.1% $KMnO_4$. At the end of 24 hr in NaOH, all tumors were found to be completely decolorized. This may be regarded as a positive reaction, since melanin is bleached by concentrated NaOH.

Tumors in $KMnO_4$ were allowed to remain for 24 hr, then rinsed in several changes of distilled water, and immersed in 0.3% oxalic acid. In all cases, after 12–24 hr in oxalic acid no trace of the dark masses could be found, the pigmented sheath evidently having been completely oxidized. This too may be regarded as a positive test.

Since the results in both cases are those expected of melanin, it would appear that the assumptions previously made concerning the nature of the pigment are correct.

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An Internal Geiger Counter for the Assay of Low Specific Activity Samples of Carbon 14 and other Weak Beta Emitters in Biological Samples[1]

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The limiting factor in biological experiments with radioactive tracers is the great dilution of the isotope. Further increases in the specific activity of the isotopic compound are often impossible because of its limited availability or because of the biological effects of the radiations. Improvements in counting techniques offer the only practical solution. The procedure described here permits statistically valid analyses of samples having one-fifth or less the activity necessary for mica-window tubes.

The windowless Geiger tube of the continuous gas flow type shown in the accompanying figures (Figs. 1 and 2) permits the counting of all particles escaping from the sample. A satisfactory counting gas is a mixture of helium and alcohol vapor. The helium is bubbled through absolute ethyl alcohol kept at 0° C in an ice bath and the gas mixture passed through the counter.

The counter can be successfully operated with commercially available scaling circuits. The material to be assayed must be spread in fairly uniform thickness on a flat surface or shallow cup within a measured area. Samples of tissues are prepared by spreading an aqueous homogenate of the tissue on a flat copper disk of 2-in. diameter which has been cleaned with ether and oxidized in an oven at 160° C overnight. The spreading may conveniently be done while the copper disk is revolving at the rate of 5 to 20 rpm on a turntable and under a gentle current of dry air. Samples of blood, urine, and solutions or suspensions of water-soluble or insoluble substances may also be spread out in this manner. The sample so prepared may then be inserted in the sliding tray and pushed into the counter.

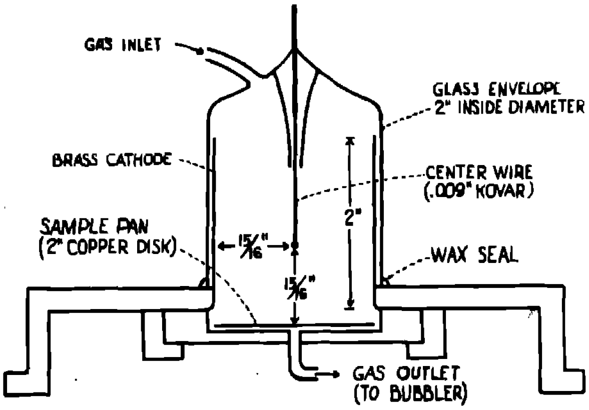
GAS INLET
GLASS ENVELOPE 2" INSIDE DIAMETER
BRASS CATHODE
CENTER WIRE (.009" KOVAR)
SAMPLE PAN (2" COPPER DISK)
15/16"
2"
15/16"
WAX SEAL
GAS OUTLET (TO BUBBLER)

FIG. 1. Cross-sectional view.

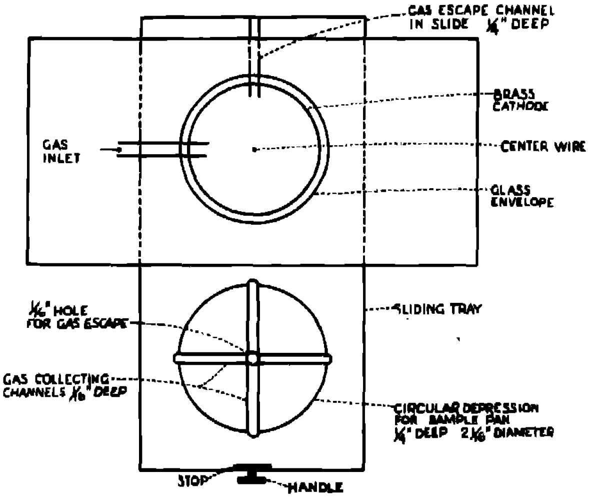
GAS ESCAPE CHANNEL IN SLIDE 1/4" DEEP
BRASS CATHODE
GAS INLET
CENTER WIRE
GLASS ENVELOPE
1/16" HOLE FOR GAS ESCAPE
SLIDING TRAY
GAS COLLECTING CHANNELS 1/16" DEEP
CIRCULAR DEPRESSION FOR SAMPLE PAN 1/4" DEEP 2 1/16" DIAMETER
STOP
HANDLE

FIG. 2. Top view.

A simplified version of the Geiger tube can be made omitting the sliding arrangement for insertion of the sample and including a side arm for a gas outlet. In this case the sample is placed on the copper disk as usual, the copper disk on a flat brass plate, and the counter over the sample. The tube can be made relatively airtight by pressing down on the glass tube or by using stopcock grease or wax at the junction of the glass tube and brass plate. Since the counting gas is always under a slight positive pressure, small leaks are of no importance. This counter may also be used for monitoring relatively flat surfaces such as laboratory tables for low-energy beta particles.

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[1] This work was aided by grants from the Life Insurance Medical Research Fund, the United States Public Health Service, and the Dr. Wallace C. and Clara A. Abbott Memorial Research Fund of the University of Chicago.

The plateau has less than a 4% rise per hundred volts from 1350 to 1550 volts. In this laboratory, the background of the counter shielded with 2 in. of lead is 28 cpm at 1375 volts. A 10-mg sample of barium carbonate containing 0.0005 µc of C^{14} spread on a 10-cm^2 surface, gave a counting rate of 564 cpm (uncorrected) at 1375 volts. The sensitive area available on the sample holder is 20 cm^2. The counting gas is inexpensive and readily available. The counter is simple to construct or may be obtained commercially.[2] The time required for replacing a sample and flushing the counter is less than 3 min.

Embryo Size and Productivity in Segregating Generations of Tomatoes[1]

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Much work has been done on size of embryos and their relationship to plant vigor in both inbred and F_1 hybrid populations; but the authors are not aware of similar experimental data in segregating generations except Faberge's (*4*) suggestion that early vigor in F_2 generations may be caused solely by initial seed weight advantage. Ashby (*1*) postulated that hybrid vigor in F_1 tomato lines was due to the possession by the hybrid of a larger embryo than that of the parental strains. Luckwill first confirmed this (*9*), but later (*10*) found evidence to indicate that no general relationship exists between embryo size and increased physiologic efficiency of F_1 hybrids. Other workers also have disagreed with Ashby's theory (*3, 5, 6, 8, 11, 13*).

Some experiments (*1, 2, 7, 8, 11, 13, 14*), however, have indicated that many F_1 lines showing hybrid vigor had larger seed or embryo size than the parental strains from which the hybrids were developed. Hatcher (*6*) has shown that size of seed in tomatoes is determined to a great extent by the number of seeds in a fruit. Natural self-pollination results in greater seed set per fruit than cross pollinating by hand; therefore, seeds from self-pollination are generally smaller in size. This does not explain the increase in size of a portion of the F_2 seeds (i.e., those produced by F_1 plants). Undoubtedly genetic control is also a factor in embryo size.

If it is assumed that in certain specified F_1 lines large size of seed is associated with hybrid vigor as measured in yields of fruit, and that such an association is carried into the segregating F_2 generation, a method is suggested whereby hybrid tomato seed may be produced by selection of seed harvested from F_1 fruits. It is possible to theorize further that if no relationship exists between seed size in tomatoes and productivity in an F_1 line showing considerable hybrid vigor, seed size and vigor may still be related in the segregating generation where transgressive segregation may occur. The first measurable evidence of vigor in segregating progenies might presumably be in larger embryo or seed size.

TABLE 1

Average Weight per Seed in mg

Generation	Diameter of seed 3000 + µ	2500–3000 µ	2000–2500 µ	Mean
P_1 Rutgers	3.43	2.89	2.38	2.90
P_2 Pritchard	3.48	3.15	2.56	3.05
F_1 R × P	3.78	3.31	2.91	3.33
F_2 R × P	3.69	3.01	2.29	3.00
Mean	3.58	3.00	2.52	...

Preliminary results have supported these possibilities. The correlation coefficients computed between seed weight and embryo weight and between average seed diameter and embryo weight were 0.978 and 0.867 respectively. Both exceed the 1% level of significance. Average seed diameter has, therefore, been used as a measure of seed weight, which in turn was used as a measure of embryo size. One-pound seed lots of two inbred strains of tomatoes, their immediate cross, and seed taken from F_1 generation fruits were sieved through soil screens with spherical openings averaging 3000, 2500, and 2000 µ. Table 1 indicates the average diameter and weight for each size class.

TABLE 2

Early and Total Yields in Tons per Acre

Generation and size of seed	8/13/48 to 9/2/48		8/13/48 to 9/30/48	
Mean of Rutgers	2.4		17.3	
Mean of Pritchard	5.9		18.1	
F_1 from seed averaging 3.78 mg	7.0	$\overline{F}_1 = 6.1$	20.6	$\overline{F}_1 = 19.6$
F_1 from seed averaging 3.31 mg	6.2		20.1	
F_1 from seed averaging 2.91 mg	5.2		18.1	
F_2 from seed averaging 3.69 mg	5.6	$\overline{F}_2 = 5.6$	19.4	$\overline{F}_2 = 18.7$
F_2 from seed averaging 3.01 mg	5.9		18.5	
F_2 from seed averaging 2.29 mg	5.2		18.1	
Significant difference 19 : 1	0.89		1.30	
Significant difference 99 : 1	1.19		....	

The average deviation in seed weight within the inbred and F_1 materials was 26.5%; in the F_2 it was 38.0%. Assuming that the deviation in the F_1 and inbred lines was environmental (*12*), then 30% of the total variation in seed producing the F_2 progenies was due to hereditary factors.

The field trials included plants grown from each seed-size class for each generation (P_1, P_2, F_1, F_2). A split-plot design having six replications was used. Information was obtained on earliness, vigor of plants, size and shape of fruits, uniformity, and yield. Yields are of

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[1] Authorized for publication on January 10, 1949 as Paper No. 1500 in the Journal Series of the Pennsylvania Agricultural Experiment Station.

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[2] From the N. Wood Counter Laboratory, Box 76B1, Chesterton, Indiana.

primary importance and will be used to illustrate the preliminary results. Table 2 shows the mean yields obtained for Rutgers and Pritchard and the three seed-size classes producing the F$_1$ and F$_2$ generations of plants.

The preliminary results for this specific tomato hybrid appear to agree with the proposed hypothesis. It will be noted that the mean yield of the F$_2$ progenies, produced from the largest seed-size class, is comparable to the mean yield of progenies obtained from all seed sizes of the immediate cross. The smallest seed-size class producing the F$_1$ generation was, however, lower in production than its two larger seed classes, possibly due to accidental inclusion of a few self-pollinated seeds of the female parent, Rutgers. The fact that early yield in the smallest seed-size class was significantly less than in the other two classes also substantiates the supposition. Had the smallest class been comparable to the other two, the average total production in the F$_1$ generation progenies would have been 20.3 tons as compared to 19.4 for the largest seed class producing the F$_2$ generation progenies. More extensive field trials are planned for the coming season.

If a measurable association can be shown to exist between size of seed extracted from F$_1$ fruits and productivity in the F$_2$ generation progenies, a new method of producing hybrid seed in volume may result. Breeders of pure line tomato strains may also benefit by being able to select for vigor by seed size, thus eliminating the growing of considerable undesirable material.

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Hypersensitivity in Cold-blooded Animals. II. Salamanders

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In a study of the effect of histamine on intestinal smooth muscle preparations of fish, Dreyer (*2*) observed that histamine produced contractions in teleost but not in elasmobranch smooth muscle. In a subsequent study Dreyer and King (*3*) were able to produce anaphylaxis in several teleost species, using as antigens horse serum and egg albumen injected intraperitoneally. Similar studies using elasmobranch species proved to be impractical because of technical difficulties. A search was then instituted for other cold-blooded animals which would show the same inability to react to histamine stimulation as elasmobranch species and be more suitable subjects in which to attempt protein sensitization.

Previous investigations using frogs as experimental animals have yielded results which are conflicting and difficult to interpret. Friedberger and Mita (*4*) shocked frogs sensitized to sheep serum and noted that the shocked animals displayed a weakness and curious loss of muscle tone. Isolated heart and other organ preparations failed to yield clear-cut results. Arloing and Langeron (*1*) failed to note any signs of hypersensitivity in their series of frogs treated with human serum. Kritchevsky and Birger (7) used frogs in which the blood was replaced by a colloid-free salt solution and noted that mammalian serum showed primary toxicity for these animals. Goodner (*6*) failed to produce satisfactory *in vivo* reactions using egg albumen and horse serum as antigens but did notice in the excised heart indications of developing hypersensitization. Friede and Ebert (*5*) demonstrated passive anaphylaxis in frogs and in some instances were able to produce symptoms of hypersensitivity in frogs actively sensitized. It is suggested that these widely divergent results, to which must be added our own negative results (*3*), were perhaps due to differences in the nutrition of the various experimental animals used. In some instances, frogs which had been held all winter without feeding failed to react, whereas frogs caught and used in the summer months showed irregular reactions that possibly might be considered significant.

Because of these variations the American newt (*Triturus viridescens*) was selected as a closely related species, which could be easily kept in the laboratory, and which could be fed without difficulty. *In vitro* and *in vivo* studies of possible hypersensitization were made in these animals. It was soon found that the tiny size of newt organs made them unsatisfactory for kymographic studies, and later studies were carried out using the mudpuppy (*Necturus maculosus*). During the investigation, the newts were kept at room temperature in a closed aquarium jar, in a few inches of water with access to rocks. They were fed three times a week and would accept only live food, taking flies and earthworms readily. With the coming of cold weather they ceased to feed, and the series, which was almost completed, was discarded. The mudpuppies were kept in running water at 18° C and refused to feed when offered earthworms, sliced rabbit liver, or rat meal. They were well fed on arrival and were all used within a month; most of the earlier animals sacrificed for tissue had food in the gut.

Injections were made intraperitoneally at a point midway between the front and hind legs. Horse serum was the only antigen used. This was about 10 months old but had been stored at −20° C without preservative. Sensitizing and shocking doses, which ranged from 0.05 to 0.10 ml for the newts and 0.20 to 0.30 ml for the mudpuppies, were spaced at irregular intervals, never less than 10 days apart.

In vitro studies were made on "Straub heart" or strips of intestine or stomach, using the usual recording methods for these preparations. All chemicals used in the kymographic studies were made up in frog saline solution.

A series of 14 American newts were injected intraperitoneally with 0.05 ml of horse serum in an attempt to sensitize them. At the same time four other newts were set aside uninjected as controls and were held under conditions comparable to those of the test group. All of the test animals were reinjected, using 0.10 ml of horse serum; two each at intervals of 18, 23, 28, 42, 48, 55, and 65 days after the initial injection. A control animal was injected with the same dose of antigen along with the first four pairs of test animals injected. No demonstrable evidence of hypersensitivity was observed. Similarly, the injections of the control animals produced no results. Two animals died subsequent to injection, but autopsy revealed evidence of trauma that could account for the deaths. Three animals received three injections each at irregular intervals, without reaction.

The injection of test and control animals with 5 γ of histamine phosphate produced no reaction, but 10 γ produced a transitory reaction of obvious distress.

Muscle preparations using a section of the duodenal end of the intestine were disappointing, because the small size of the material rendered kymographic studies difficult. However, it appeared that in three muscle preparations studied, histamine 10 γ, epinephrine 10 γ, and horse serum 0.2 ml produced no demonstrable effect. Barium chloride, 2% solution, produced significant contractions of the gut, showing the ability of the muscle to respond. Heart and stomach preparations were not studied in the newt because of the technical difficulties involved. In view of the results of the organ studies, it was felt that the reaction *in vivo* with 10 γ histamine was an artifact caused by the relatively large size of the dose administered.

Of five mudpuppies obtained, two were sacrificed, without previous attempts to sensitize them, for kymographic studies of heart, stomach, and intestine; and three were injected intraperitoneally with 0.2 ml of horse serum. As this produced no evident reaction, the animals were reinjected four days later, using 0.25 ml antigen in an effort to build up the allergic state. Again there was no immediate reaction, but one animal died two days later; autopsy showed blood in the abdomen, the cause of which was probably the trauma of injection. The remaining two animals were injected again 18 days after the first sensitizing dose and showed no symptoms of shock. Five days later these animals were sacrificed for study of isolated organ preparations.

In kymographic studies of Straub heart preparations of both normal and serum-injected animals, histamine in doses as high as 10 γ and horse serum in 0.2-ml doses failed to exert any effect on the contractility of the heart. Similar doses of histamine and horse serum failed to produce demonstrable responses when administered to stomach or intestinal preparations. One γ of epinephrine produced a marked increase in the amplitude of the myocardial contractions, while the same amount of acetylcholine depressed the contractility of the heart. These reactions were in agreement with those observed using fish Straub heart preparations (*2*) and our unpublished experiments with frog preparations.

As a result of these data it can be concluded that, while teleost fish have the ability to become sensitized to protein antigens, are able to show histamine shock, and can show smooth muscle contractions in the preparations *in vitro* treated with histamine, the American newt and the mudpuppy have none of these characteristics. Acetylcholine depresses the activity of frog, salamander, and fish heart, but seems to play no role in hypersensitization. It is suggested that these data be used as additional evidence of the role of histamine in anaphylaxis.

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Inactivation of Amino Acids by Autoclaving[1]

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Recent work has shown that cystine is the only amino acid partially destroyed by autoclaving casein for 20 hr at 15 lb pressure (*3*). Lysine, arginine, and tryptophan suffer partial destruction when casein (*5*) or soy globulin (*6*) is refluxed for 24 hr in a glucose solution, or when soybean oil meal is autoclaved for 4 hr (*7*). The amounts of aspartic acid, isoleucine, lysine, methionine, and threonine liberated by enzymatic digestion from casein *in vitro* are decreased after autoclaving (*3*), as are all of the amino acids in soybean oil meal (*7*).

Evans and Butts (*1*) found that autoclaving causes two types of inactivation of lysine, one a reaction of the lysine with sucrose to destroy it and the other a reaction with protein to render it unavailable after enzymatic digestion *in vitro*. Moreover, methionine reacts with sucrose or glucose to form a linkage not hydrolyzed by enzymes *in vitro* (*2*).

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[1] Published with the approval of the Director of the Michigan Agricultural Experiment Station as Journal Article No. 1007 (new series).

The present investigation was carried out to study the mechanism of amino acid inactivation by autoclaving. Soybean protein,[1] and a mixture of 8 g of soybean protein and 2 g of sucrose, were autoclaved for 4 hr at 15 lb pressure. Unautoclaved protein was used as a control. Total and available amino acid contents of the proteins were determined by microbiological assay after either acid or enzymatic digestion *in vitro* as described previously (*1*, *2*). *Leuconostoc mesenterioides* P–60 was used for lysine, methionine, cystine, and aspartic acid assays; *Lactobacillus arabinosus* 17–5 for leucine, isoleucine, valine, threonine, phenylalanine, and glutamic acid; *Streptococcus faecalis* R for histidine; and *Lactobacillus casei* for arginine. The media of Sauberlich and Baumann (*3*) were used for all assays except methionine and cystine for which the oxidized peptone medium of Lyman, *et al.* (*4*) was used.

TABLE 1

AMINO ACID INACTIVATION CAUSED BY AUTOCLAVING SOYBEAN PROTEIN ALONE OR WITH SUCROSE

	Acid hydrolysis			Enzyme hydrolysis		
	Total amino acid content %	% Lost on autoclaving	% Lost on autoclaving with sucrose	Available amino acid content %	% Lost on autoclaving	% Lost on autoclaving with sucrose
Arginine	6.91	3	42	6.62	8	55
Lysine	4.65	3	47	3.07	30	84
Histidine	2.29	8	10	1.97	16	42
Aspartic acid	5.75	7	6	1.04	37	84
Glutamic acid	17.10	2	3	4.74	24	50
Cystine	0.27	9	22	0.21	14	86
Methionine	1.12	8	2	0.62	6	41
Phenylalanine	5.17	0	0	4.00	9	14
Threonine	3.28	4	1	2.14	8	15
Leucine	7.31	2	0	6.14	8	13
Isoleucine	5.83	0	0	4.92	8	8
Valine	6.32	2	0	5.19	8	8

The results are summarized in Table 1. None of the amino acids was significantly destroyed by autoclaving soybean protein alone; but when the protein was mixed with sucrose prior to autoclaving, over 40% of the diamino acids, lysine and arginine, was destroyed. This destruction was caused, apparently, by a reaction of the free amino groups with sucrose, because more than 45% of each of the free amino acids used, except cystine, was destroyed when added to the protein-sucrose mixture before autoclaving (Table 2). Protein-bound cystine was also partially destroyed (22%) by the treatment.

TABLE 2

INACTIVATION OF FREE AMINO ACIDS CAUSED BY AUTOCLAVING WITH SOYBEAN PROTEIN OR WITH SOYBEAN PROTEIN AND SUCROSE

	Percentage of added amino acid destroyed*		Percentage of added amino acid inactivated†		Percentage of added amino acid inactivated but not destroyed	
	Autoclaved with soybean protein	Autoclaved with soybean protein + sucrose	Autoclaved with soybean protein	Autoclaved with soybean protein + sucrose	Autoclaved with soybean protein	Autoclaved with soybean protein + sucrose
Arginine	7	45	2	50	0	5
Lysine	7	56	31	75	24	19
Aspartic Acid	22	57	33	56	11	0
Cystine	8	20	30	50	22	30
Methionine	2	79	7	74	5	0
Phenylalanine	15	59	21	70	6	21
Valine	14	46	25	52	11	6

* Percentage of added amino acid destroyed was calculated from the difference in recovery of amino acid from acid digests of the autoclaved and unautoclaved materials.

† Percentage of added amino acid inactivated was calculated from the difference in recovery of amino acid from enzyme digests *in vitro* of the autoclaved and unautoclaved materials.

Autoclaving the mixture of soybean protein and sucrose, decreased the amounts of all amino acids liberated by enzymatic digestion *in vitro*, some to a greater extent than others. Aspartic and glutamic acids were also partially inactivated when the protein was autoclaved in the absence of sucrose, possibly by a reaction of their free carboxyl groups with the free amino group of lysine to give a linkage resistant to enzymatic digestion. Cystine, methionine, and histidine inactivation was primarily caused by a reaction with sucrose to form an enzyme-resistant linkage. As only small amounts of phenylalanine, threonine, leucine, isoleucine, and valine were inactivated, it appears that the amino acids which are inactivated are those with free amino or carboxyl groups, or with other active groups such as the sulfur of cystine and methionine, or the imidazole of histidine.

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[1] "Alpha" protein furnished by The Glidden Company, Chicago.

Representative free amino acids were added to samples of soybean protein and the protein-sucrose mixture before autoclaving. The results are presented in Table 2. No relation between the behavior of free and protein-bound amino acids is apparent. Except for lysine, cystine, and phenylalanine, destruction accounted for practically all of the inactivation. The important point is that, except for cystine which is very insoluble under the conditions of autoclaving, over 45% of each of the free amino acids was destroyed when autoclaved with a mixture of soybean protein and sucrose.

From the results of this investigation it appears that at least three types of reaction are involved in the inactivation of amino acids by prolonged autoclaving of a sucrose containing food or feed, such as soybean oil meal. Lysine, aspartic, and glutamic acids combine with some constituents of the protein, probably the free carboxyl with the free amino groups, to form enzyme-resistant linkages. The amino acids with free amino groups react with sucrose to destroy the amino acids. Protein-bound methionine, cystine, and histidine with sucrose form linkages resistant to enzymatic hydrolysis *in vitro*.

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Improved Apparatus for Radiobiological Syntheses[1]

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Radioactive natural compounds, invaluable tracers for studying intermediary metabolism, are most conveniently prepared by radiobiological methods. Livingston and Medes (*4*) demonstrated that a detached leaf can efficiently photosynthesize $C^{14}O_2$ into C^{14} carbohydrates. Aronoff, Benson, Hassid, and Calvin (*1*) first reported a preparation of radioactive C^{14} glucose; and Putnam, Hassid, Krotkov, and Barker (*6*) have given detailed instructions for preparation. However, the apparatus designs employed by these pioneer workers warrant considerable improvement. A simplified photosynthesis apparatus and procedure, used to prepare C^{14} glucose for poliomyelitis studies, is described in this paper.

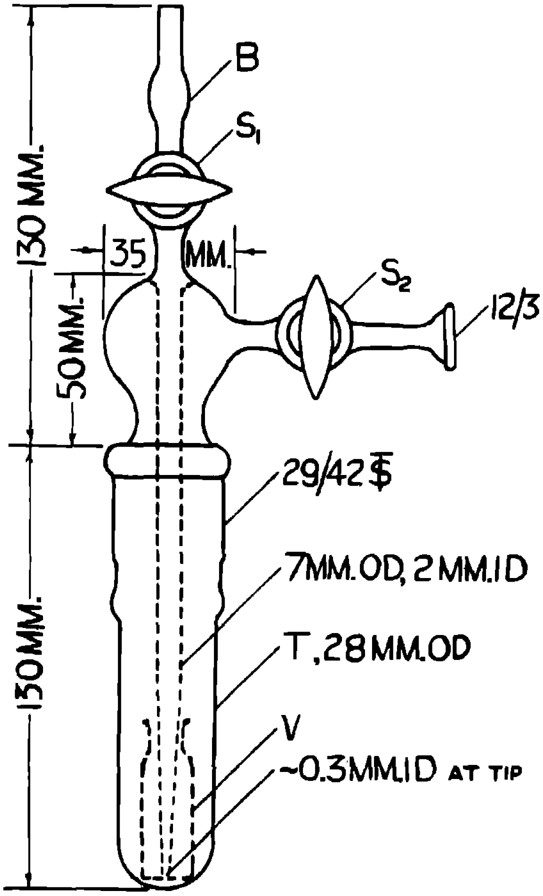

FIG. 1. Photosynthesis vessel.

Tube (T) (Fig. 1) is rinsed with water and left moist. A mature sweet potato leaf (petiole detached, fresh weight about 850 mg), which was removed from a plant in the light about 18 hr earlier, wet thoroughly, wrapped in wax paper and stored in the dark, is now arranged (under side facing in) about the inner surface of the tube. A 6-ml vial (V), containing 50 mg of $BaC^{14}O_3$, moistened to avoid possible scattering, is placed at the bottom of the tube; the standard taper joint lubricated; and the photosynthesis vessel assembled as shown. The vessel is evacuated through stopcock (S_2), 0.5 ml of 3N $HClO_4$ is introduced into bulb (B) by means of a narrow-tipped dropper, and stopcock (S_1) is carefully opened to admit the acid to the carbonate. When the

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[1] This work was aided by a grant from the National Foundation for Infantile Paralysis.

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acid solution is clear and no longer effervescent, carbon dioxide-free air is admitted through stopcock (S_1) to restore the internal pressure to atmospheric. Finally, the vessel is slipped into a stiff wire holder so adjusted that the vessel is disposed parallel to and 5 cm from a 40-watt fluorescent lamp. The above manipulations can be carried through in 7 min or less.

After photosynthesis has continued for 24 hr, 2 CO_2 absorption vessels, each containing 10 ml of 0.05N $Ba(OH)_2$ solution, 5% in $BaCl_2 \cdot 5H_2O$, are attached as shown in Fig. 2. The second vessel connects with a Mariotte bottle, the outlet tube of which is lowered to obtain an air flow of about 10 ml per min through the system when the stopcocks are opened. After 20 min of aeration, excess $Ba(OH)_2$ is back-titrated with standard HCl, using phenolphthalein indicator. Essentially no CO_2 reaches the second absorption vessel.

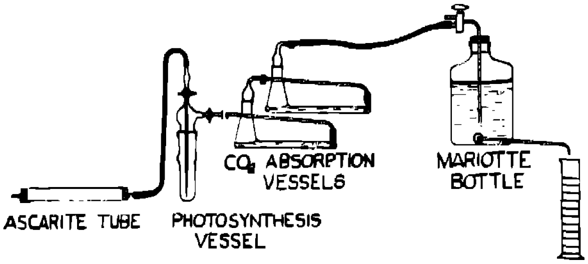

FIG. 2. CO_2 absorption train.

It was found from seven preliminary runs with inactive CO_2 that an average of 0.27 mg CO_2 was assimilated per mg dry weight of sweet potato leaf in a 24-hr run under the described conditions. For a 10-hr run, 52% of this amount was assimilated; for a 2-hr run, 12%. In every 24-hr run where the amount of CO_2 was not in excess, essentially quantitative (98.8–99.6%) assimilation of available CO_2 took place.

A simplified procedure, based on the fractionation scheme of Hassid, McCready, and Rosenfels (*3*), was used to isolate C^{14} glucose. The leaf was homogenized, filtered, and extracted 1 hr with 5 ml of 80% alcohol. Five ml of 1N H_2SO_4 was added to the extract, which was hydrolyzed for 30 min with simultaneous elimination of the alcohol by distillation. A small excess of hot 10N $Ba(OH)_2$ was added, the suspension slightly re-acidified with H_2SO_4 and brought to final neutrality with solid $BaCO_3$. After centrifuging off the residue and adding 300 mg of carrier glucose, the sugar solution was concentrated under vacuum to a syrup, taken up in 10 ml of 95% alcohol, brought to turbidity with ether, and set aside for glucose crystallization.

The extracted leaf residue was boiled 15 min with 5 ml of acid alcohol (4 ml of concentrated H_2SO_4 stirred into 500 ml of 95% alcohol), and extracted 15 min. The residue was then boiled 1 hr with 5 ml of water and water extracted 15 min. The combined aqueous starch solutions were then treated in exactly the same manner as described for the 80% alcohol extract, except that acid hydrolysis was continued for 1 hr, and only 100 mg of carrier glucose were needed to assure satisfactory crystallization.

There were obtained from the starch extract 69 mg of crystalline glucose, 0.25 µc/mg, and from the soluble sugar extract 189 mg, 0.027 µc/mg.[a] Of the total activity assimilated, 26% was accounted for in the starch and soluble sugar extracts, 11% in the $BaSO_4$ residue from the alcohol extract, and 32% in the residual leaf material.

The sweet potato was used because of the ease of maintaining a continuous leaf supply for preliminary work. For the specific purpose of glucose preparation, other leaves are apparently superior. Whereas the potato leaf fixed 26% of the assimilated activity as starch and soluble sugar, Aronoff *et al.* (using the barley seedling) report 25 to 35%, Putnam *et al.* (using the tobacco leaf) apparently report 45 to 55%, and Livingston and Medes (using the bean leaf) claim 90% fixation.

Significant improvements will now be summarized: (1) A compact and simplified photosynthesis vessel permits considerable economy of time and effort in manipulation. (2) No special devices or leaf pretreatment are necessary to preserve humidity or the water content of the leaf, as evidenced by the fresh turgid condition of the leaf after a 24-hr photosynthesis period and by the essentially quantitative assimilation of a substantial amount of CO_2 during this period. (3) No special temperature control apparatus is necessary, despite the proximity of light source and leaf. (4) The evolution of CO_2 within the vessel is rapid yet under positive control, eliminating the spattering hazard.

Perhaps the greatest advantage is the adaptability of the apparatus to subsequent fractionation procedures. For example, the leaf may be directly homogenized in the photosynthesis tube by the insertion of a rotating pestle, after the manner of Potter and Elvehjem (*5*). Centrifugation or, with the use of the universal microapparatus to be described elsewhere (*2*), filtration and extraction procedures are possible without transfer of the plant material. Any such minimization of transfer is highly desirable when dealing with small amounts of material, especially radioactive material.

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[a] These are approximate values as based on the stated activity of a $BaC^{14}O_3$ shipment from Oakridge.

Comments and Communications

Animal Experimentation in the District of Columbia

On September 15, 1948, the executive committee of the AAAS adopted unanimously a resolution reaffirming its support for animal experimentation, in the interests of man and other species, and stating its belief that animals for research and teaching should be provided by legislation or ordinance where necessary. Such legislation has been adopted in Michigan and Minnesota, and ordinances of the type supported are in effect in Chicago, Dallas, and many other cities. Similar proposals have been defeated in Pennsylvania and deferred in Maryland, Massachusetts, and elsewhere. The campaign nationally, under the auspices of the National Society for Medical Research, for positive legislation of this sort, is at a stage of rather precarious dynamic equilibrium.

In April bills were introduced in Congress to provide a fraction of the unclaimed impounded animals in the District of Columbia for teaching and research in local institutions inspected and licensed by the Health Department. At present, such animals are slaughtered. Because Congressional action is called for, a good deal of national interest has been aroused, although the bills are District of Columbia measures. The antivivisectionists, at least, realize the wider significance of the measures, and have organized a national telegram-and-letter campaign which, together with display advertising in local newspapers, has resulted in a flood of communications to Congressmen and the District of Columbia Commissioners. Since Senate hearings have ended, it is especially important that letters and telegrams of support be sent the District of Columbia Committees of House and Senate. The AV's have thousands of dollars in their local treasuries for this campaign.

The Committee for Health and Research, composed of local teachers, physicians, scientists and other friends of progress in medicine and related fields, have *no* funds and, since the Committee was organized only recently, few members. We cannot match, therefore, such efforts as the opposition's national mailing to members and friends of the American Humane Association. Through the columns of *Science*, however, we hope to galvanize the silent majority (amounting, according to sampling of the public, to more than 90% of the American people) on our side.

The Committee ask that readers of *Science* (1) write letters or send telegrams to the District of Columbia Commission and to the District of Columbia Committees of House and Senate, supporting H.R. 4349 and S. 1703; and (2) secure similar action by organizations of all types—parent-teacher associations, citizens' groups, unions, faculties of educational institutions, and professional, scientific and industrial bodies—of which readers are members.

The Committee will be glad to furnish copies of the bills and other information upon request. The fate of H.R. 4349 and S. 1703 will affect the supply of animals for teaching, research and consumer testing in every community in the United States. Quick support is essential.

WILLIAM F. HEWITT, JR.

Executive Secretary,
Committee for Health and Research

Interpretation of Lindner's Test for Plant Virus Diseases

In using Lindner's colorimetric test for the presence of plant virus diseases (*Science*, 1948, 107, 17) in a tissue culture of virus tumor discovered and isolated by L. M. Black in 1944, it became apparent that the method described by Lindner for virus presence is a modification of the Benedict test for reducing substances. The components of the reagent are similar to those in Benedict solution—an alkaline solution of copper sulfate. Lindner says, "Copper sulfate seems to catalyze the formation of the red color." Actually the copper sulfate is the reagent, being reduced to cuprous oxide, hence accounting for the red color produced. The blue-green color resulting when normal, virus-free leaves were tested probably came from the reducing substances normally present; and the red color, when virus-infected leaves were tested, from an abnormal accumulation of reducing substances. In Cook's *Viruses and virus diseases of plants*, there are conflicting reports concerning the accumulation of reducing substances in virus-infected plants.

The interfering factor, girdling, can be accounted for, since it is well known that the procedure causes accumulation of carbohydrates and apparently reducing substances above the ringed portion.

Lindner's interpretation of the test—that the virus may cause some disturbance in the phloem—can be extended to include the idea that it also causes accumulation of reducing substances.

The following materials were tested for the presence of virus disease, according to the method outlined by Lindner:

MATERIAL	AMOUNT OF RED COLOR PRODUCED (CUPROUS OXIDE FORMED)
Glucose	+++
Virus tumor	+++
Agar on which tumor was grown	++
Virus-free pea leaves	+

This communication does not decry the usefulness of the test as a detector of virus diseases, but urges that when it is used, the results be interpreted in terms of reducing substances present.

SALLY KELLY

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Note on the Chemistry of Dramamine

In the treatment of various allergies by the antihistaminic drugs which have appeared so profusely in the last few years, there have been observed undesirable side reactions, such as drowsiness, which detract from their usefulness. Attempts have been made with certain of the antihistamines to offset the drowsiness by chemical combination with the methyl xanthines, selected because of their central nervous stimulating properties. Because of the low ionization constants of the methyl xanthines, however, no stable salts were obtained.

The chemical problem has been solved in the case of β-dimethylaminoethyl benzohydryl ether (Dramamine) by the use of 8-chlorotheophyllin, which has a high enough ionization constant to form a stable salt.

The salt is readily made by dissolving the 8-chlorotheophyllin with a slight excess of the base in any suitable hot organic solvent, such as methyl ethyl ketone or ethanol. On cooling, it precipitates as a nice sandy material in almost quantitative yield based on 8-chlorotheophyllin, mp 101–3° C, empirical formula $C_{24}H_{28}O_3N_5Cl$.

Analysis:	Theory %	Found %		
Chlorine	7.56	7.45	7.46	7.51
Basic N	2.98	2.98	2.98	
8-Chlorotheophyllin	45.67	45.65	45.62	

The use of this compound in preventing motion sickness was reported by Leslie N. Gay and Paul E. Carliner at the meeting of the Johns Hopkins Medical Society, February 14, 1949, and a statement was published in *Science*, April 8, 1949.

JOHN W. CUSIC

G. D. Searle and Company, Chicago

Association Affairs

K. Lark-Horovitz, head of the Department of Physics and director of the Physical Laboratory at Purdue University, has been elected general secretary of the AAAS for the term ending 1952. His election follows a brief period of service to complete the unexpired term of the late Otis W. Caldwell.

Dr. Lark-Horovitz is best known for his researches in the physics of solid state and nucleonics and for his recent experimental investigations and theoretical interpretations of the behavior of electronic semiconductors. He is chairman of the Cooperative Committee on the Teaching of Science for the association and was one of the contributors to Vol. IV of the President's Scientific Research Board Report.

The new secretary will also serve on the Publications Committee.

Affiliated and Associated Societies[1] Meeting with the AAAS New York, December 26–31

Nearly all of the affiliated and associated societies meeting with the American Association for the Advancement of Science at its 116th Annual Meeting in New York City, December 26–31, 1949, have reported the preliminary estimates of their session room requirements. The following list of individual meetings is compiled from the reports of the secretaries of these societies and sections. (The exact dates of each within the six-day period are tentative in only a few instances.)

AAAS.—Presidential Session and Reception of AAAS, evening of Dec. 28; Symposia sponsored by AAAS, afternoon of Dec. 29. (Association headquarters hotel, Statler.)

A—Mathematics.—American Mathematical Society, Dec. 27–29; Institute of Mathematical Statistics;[2] Mathematical Association of America, Dec. 29, 30. (Mathematicians Headquarters hotel, Governor Clinton.)

B—Physics.—Section B, Dec. 29, 30.

C—Chemistry.—Section C, Dec. 29–31. Phi Lambda Upsilon.

D—Astronomy.—Section D.

E—Geology and Geography.—Section E and Geological Society of America, joint meeting; American Geographical Society of New York; Association of American Geographers; National Geographic Society, Annual Lecture, afternoon of Dec. 27.

F—Zoological Sciences.—Section F; American Society of Parasitologists, Dec. 27–29 (including demonstrations at Columbia); American Society of Zoologists, Dec. 28–30; Society of Systematic Zoology, Dec. 29. Zoologists' headquarters hotel, Statler.)

FG—Zoological and Botanical Sciences.—American Microscopical Society, Dec. 27 and 30; American Society of Limnology and Oceanography, Dec. 28–30; American Society of Naturalists, Dec. 30 (Biologists' smoker probably Dec. 29); Beta Beta Beta Biological Fraternity, Dec. 28; Biometric Society, Eastern North American Region; Ecological Society of America, Dec. 27–29; Genetics Society of America, Dec. 28–30 (including demonstrations at Columbia); American Society of Human Genetics; National Association of Biology Teachers, Dec. 27–30; Society for the Study of Evolution, Dec. 27–30, a panel discussion of "Botany in the Service of Mankind."

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[1] Notices of the dates and places of the meetings of affiliated and associated societies, *not* meeting with the AAAS, appear in *Science* and *The Scientific Monthly* whenever that information is sent in directly to the editorial offices.

[2] These societies also are participating in the programs of the Allied Social Science Association organizations which are meeting at the same time in the Grand Central Zone of New York City.

G—Botanical Sciences.—Section G, Dec. 29; American Phytopathological Society, Dec. 27–30; American Society of Plant Physiologists, Dec. 27–29; American Society of Plant Taxonomists, Dec. 27–30; Botanical Society of America, Dec. 26–30; Mycological Society of America, Dec. 27–30; Torrey Botanical Club; American Fern Society; American Bryological Society, Dec. 27–28; Phycological Society of America, Dec. 27–28. (Plant sciences headquarters hotels, McAlpin and adjacent Martinique.)

I—Psychology.—Section I, Dec. 27–28 (including joint meeting with Section Q); Society for Research in Child Development, Dec. 28–29.

K—Social and Economic Sciences.—Section K; Academy of World Economics and American Economic Association,[2] joint meeting, Dec. 28; American Sociological Society, Dec. 27–29; American Statistical Association;[2] Econometric Society;[2] Pi Gamma Mu; Metric Association, Dec. 30.

L—History and Philosophy of Science.—Section L and Philosophy of Science Association, joint meeting, Dec. 29–30.

M—Engineering.—Joint meetings of Section M and Instrument Society of America, Dec. 26; Technical Society Council of New York, Dec. 27; Metropolitan Section of American Society of Mechanical Engineers, Dec. 30.

N—Medical Societies.—Section N; Subsection Np, Pharmacy, Dec. 27, 28; Alpha Epsilon Delta Premedical Honor Society, Dec. 27; American Dietetic Association.

Q—Education.—Section Q, Dec. 27, 28 (including joint meeting with Section I); National Science Teachers Association, Dec. 27–30. Science Teaching Societies affiliated with the AAAS, i.e., ANSS, NABT, NSTA and the Cooperative Committee of the AAAS, will hold joint meetings Dec. 27–29; (Science Teaching, Education and Psychology headquarters hotel, New Yorker).

X—General Science Societies.—American Nature Study Society, Dec. 27–30 (including an all-day Field Trip, the last day); Honor Society of Phi Kappa Phi, Dec. 28, 29; National Association of Science Writers; Sigma Delta Epsilon, Graduate Women's Scientific Fraternity, Dec. 28, 29; The Society of the Sigma Xi, Dec. 27 including the annual address in the evening.

Nearly all the Association's 17 Sections and Subsections are planning strong programs (synopses of the Section programs will appear in *Science* shortly). A special committee of the Executive Committee of the American Association for the Advancement of Science is arranging for the symposia in the fields of biology and physical sciences. There are numerous joint meetings and several symposia planned by the societies themselves—including one on experimental cell research, and the coordinated program of the science teaching societies in conjunction with the AAAS Cooperative Committee.

It is already apparent that the 1949 Annual Meeting will be one of the best balanced and most convenient in the Association's 101-year history. It has been possible, for instance, to concentrate the zoological and medical meetings in the Statler and nearby Governor Clinton, the educational, science-teaching and psychological meetings in the New Yorker, and all of the plant sciences in the McAlpin and adjacent Martinique. A few societies such as the mathematical groups and the Ecological Society of America, that particularly desire academic classrooms, will be accommodated in Columbia University (20 minutes away from the Penn Zone on the Broadway-Seventh Avenue or West Side subway).

Firms and other organizations of service to science have recognized that this will be one of the best attended meetings. At this time, seven months in advance, the following already have made definite arrangements to exhibit in the Penn Top of the Hotel Statler: The Albino Farms; American Book Company; American Cancer Society; American Optical Company; Appleton-Century-Crofts, Inc.; The Association of American University Presses; Bausch and Lomb Optical Company; Biological Abstracts; The Blakiston Company; Bussey Products Company; Cambridge Instrument Company, Inc.; Carolina Biological Supply Company; Fred S. Carver, Inc.; Central Scientific Company; Cinchona Products Institute, Inc.; Coreco Research Corporation; Thomas Y. Crowell Company; Denoyer-Geppert Company; International Business Machines Corporation; Eastman Kodak Company; Gamma Scientific Company; General Biological Supply House, Inc.; Harper and Brothers; Jarrell-Ash Company; Kahl Scientific Instrument Corporation; E. Leitz, Inc.; The Linguaphone Institute; J. B. Lippincott Company; The Macmillan Company; McGraw-Hill Book Company, Inc.; G. & C. Merriam Company; The C. V. Mosby Company; National Geographic Society; National Spectrographic Laboratories, Inc.; New York Scientific Supply Company, Inc.; Nuclear Instrument and Chemical Corporation; The Nucleonic Corporation of America; Pfaltz and Bauer, Inc.; Philosophical Library; Prentice-Hall, Inc.; The Rayoscope; Rinehart and Company, Inc. and Murray Hill Books, Inc.; W. B. Saunders Company; Schwarz Laboratories, Inc.; The Squibb Institute for Medical Research; The Technicon Company; Tracerlab, Inc.; Ward's Natural Science Establishment, Inc.; W. M. Welch Scientific Company; and John Wiley and Sons, Inc.

Advance registration and hotel room reservation will begin in September. There will be coupons in *Science* for both. The New York Convention Bureau will handle the reservations and the hotels will send prompt confirmations directly.

The Advisory Board of the Gordon Research Conferences has elected Charles N. Frey, director of Scientific Relations of Standard Brands, Inc., and Herman Mark, director of the Institute of Polymer Research and professor of organic chemistry, Polytechnic Institute of Brooklyn, to the Management Committee of the conferences. The Executive Committee of the AAAS has confirmed the election. Dr. Frey and Professor Mark succeed Dean Burk, National Institutes of Health, and George Calingaert, director of chemical research at the Ethyl Corporation, who will retire next September.

NEWS and Notes

National Science Foundation. The Subcommittee on Public Health, Science, and Commerce of the House of Representatives' Committee on Interstate and Foreign Commerce, has completed its consideration of science foundation bills. On May 24 the chairman, J. Percy Priest, introduced a new bill, H. R. 4846, which embodies the subcommittee's compromises and revisions of the several bills it has had under consideration.

H. R. 4846 differs in details from the earlier bills. The responsibilities of the 24-man board and of the director are more clearly defined than in earlier bills. Like most of the earlier ones, but unlike S. 247 (the bill passed by the Senate), H. R. 4846 requires the selection of an executive committee of the board. The medical commissions are optional rather than required in both Senate and House bills. Throughout H. R. 4846 there are a number of changes in wording and rearrangements of sections. These changes clarify the Foundation's operations without altering its functions.

The bill must next receive approval of the Committee on Interstate and Foreign Commerce. The earliest possible date for that approval is June 6. Then it will be ready for scheduling for a vote by the House of Representatives. All scientists who are interested in the establishment of a National Science Foundation should immediately inform their Representatives that they want H. R. 4846 passed promptly.

DAEL WOLFLE

David T. Smith, bacteriologist at Duke University, has been named president-elect of the National Tuberculosis Association to succeed **R. D. Thompson** of Pasadena, California. Dr. Smith was recently awarded a $4,000 renewal grant by the association to continue his studies of chemical agents that appear to inhibit growth of tuberculosis germs.

Richard H. Young, dean of the College of Medicine, University of Utah, has been appointed dean of Northwestern University School of Medicine. Dr. Young will succeed **J. Roscoe Miller**, who will become Northwestern's president in July.

Giles E. Hopkins, former director of applied research of the Textile Research Institute, has been appointed technical director of the Wool Bureau, Inc. He will direct a continuing study of the chemical and physical characteristics of wool.

Jacob Furth, director of the Branch Reference Laboratory, Veterans Administration Hospital at Dallas, Texas, has been appointed chief of the pathology section, Division of Biology, Oak Ridge National Laboratory.

Midwest Research Institute of Kansas City, Missouri, has announced the appointment of **Max H. Thornton** as chairman of its Chemical Research Division.

Percy Williams Bridgman, research professor of physics at Harvard University, and **Norman Levi Bowen**, petrologist in the geophysical laboratory of Carnegie Institution in Washington, have been elected to the Royal Society of Great Britain.

Paul E. Hemke, head of the Department of Aeronautical Engineering, Rensselaer Polytechnic Institute, has been appointed faculty dean of the institute. He will succeed **Matthew A. Hunter**, who is retiring at the end of the college year.

Visitors to U. S.

W. Flügge, French mechanical engineer, is teaching a course based on his book *Statics and dynamics of shells* at the Stanford School of Engineering. Dr. Flügge's wife, **Irmgard Flügge-Lotz**, is also lecturing at the school during the spring quarter on "Theory of Boundary Layer."

Visitors at the National Bureau of Standards during the week of May 16–20 included: **T. Bedford**, chief chemist, Bureau of Standards, Pretoria, South Africa; **Lars Melander**, radiochemist, Nobel Institute for Physics, Stockholm; **Marcel J. Pourbaix**, chef de travaux, University of Brussels; **Dag Hartman**, chief radio and electronics engineer, Saab Aircraft Company, Linkoping, Sweden; **A. Masson** and **A. Sable**, Société d'Electrochimie d'Ugine, Paris; **William Wild**, Ministry of Supply, Atomic Energy Research Establishment, Harwell, England.

Dominic Brachett, director of the Cancer Institute of the University of Buenos Aires, is visiting the University of Texas Medical Branch, Galveston, to work with W. W. Nowinski, director of the Neuro-Chemistry Laboratory, on enzyme factors in tissue growth.

Grants and Awards

The Passano Foundation of the Williams and Wilkins Company will present its annual $5,000 award for the advancement of medical research to Oswald T. Avery, member emeritus of the Rockefeller Institute for Medical Research. The presentation will be made on June 8. Dr. Avery, the fifth recipient of the award, will be honored for his classification, analysis, and investigation of the immunological relationships of the pneumococci.

The University of Chicago presented the first **Howard Taylor Ricketts Award** for outstanding service to medicine on May 3, the anniversary of the death of Dr. Ricketts. The medals were awarded to Ludvig Hektoen, who has been chairman of the Department of Pathology at the university and director of the McCormick Institute for Infectious Diseases, and to Russell Wilder, head of the Division of Medicine at the Mayo Clinic.

Summer Programs

The Second Canadian Mathematical Congress and Seminar will be held at the University of British Columbia, Vancouver this summer, the seminar August 16–September 10 and the congress September 5–10. Members of the American Mathematical Association are invited to attend. Further information may be obtained from the Canadian Mathematical Congress, Engineering

Building, McGill University, Montreal, Canada.

North Dakota Agricultural College will conduct a paint short course June 27–July 10. The course will stress recent developments in the technology of paint and will be administered by the university's School of Chemical Technology.

Meetings and Elections

The New Orleans Academy of Sciences, at its annual meeting at Tulane University, New Orleans on April 29–30, elected the following officers: president, L. J. Strohmeyer, Loyola University; vice president, F. R. Cagle, Tulane University; secretary, W. G. Moore, Loyola University; treasurer, J. K. Reiss, Tulane University; curator, G. F. Taylor, Tulane University; members of executive council, T. L. Duggan, Loyola University and R. Campbell, U. S. Forest Service.

The United States was doubly honored at the recent meetings of the **International Geographical Congress** held at Lisbon, April 8–15. The general assembly voted to hold the next congress, the seventh, in the U. S. in 1952, thus recognizing the centenary of the American Geographical Society, and elected as its new president George B. Cressey, chairman of the Department of Geography at Syracuse University. The congress brought together 330 geographers from some 30 countries; registration from organizations and individuals not in attendance brought the total to 706. Unfortunately, no delegates were present from behind "the iron curtain." In order to stress the international character of the union, the nine newly elected officers were chosen from nine countries, with representatives from both Asia and Latin America. The new secretary is George T. K. Kimble, of McGill University in Montreal.

The private and professional character of the International Geographical Union was reaffirmed, although in a number of countries the dues are paid by the government. Membership is through a series of national committees, each appointed by the principal academy of science or national research council which serves as the adhering organization. The union changed its statutes to provide for a new voluntary basis of membership in which each country elects to join one of eight categories with a graduated series of 1 to 15 units for the dues. Until the time of the next congress each unit has been fixed at $100. The former basis of graduated voting was abolished so that in administrative matters each national committee has an equal vote.

The principal activities of the union between sessions of the congress concern the operation of a series of commissions, 13 of which were appointed at Lisbon. These range from problems in population, ports, land use, and medical geography to periglacial morphology, soil erosion, terraces, and aerial photo interpretation.

GEORGE B. CRESSEY

The American Society for Pharmacology and Experimental Therapeutics, at its Detroit meeting, April 18–22, elected the following officers: president, Carl F. Schmidt, University of Pennsylvania; vice president, John C. Krantz, Jr., University of Maryland; secretary, Harvey B. Haag, Medical College of Virginia; treasurer, K. K. Chen, the Lilly Research Laboratories; and councilors, Thomas C. Butler, Johns Hopkins University; Arthur C. DeGraff, New York University; and Robert A. Woodbury, University of Tennessee.

The Society for General Microbiology held a symposium on "The Nature of the Bacterial Surface" at the Royal Institution in London on April 20-21. The principal speakers were N. W. Pirie, Rothamstead Experimental Station; W. T. J. Morgan, the Lister Institute for Preventive Medicine; M. Stacey, Birmingham University; Peter Mitchell, Biochemical Laboratory, Cambridge; T. F. Anderson, University of Pennsylvania; A. A. Miles, National Institute for Medical Research; E. T. C. Spooner, London School of Hygiene and Tropical Medicine; Harriet E. Taylor, Laboratoire de Genetique, Paris; A. Pijper, Pretoria University; T. Y. Kingma Boltjes, of Amsterdam; W. van Iterson and A. L. Houwink, both of Delft; D. McLean, of Elstree; Sir Alexander Fleming and W. H. Hughes, both of Paddington.

At the annual general meeting of the society the following officers were elected: president, J. W. McLeod; honorary treasurer, H. J. Bunker; and honorary secretaries, J. G. Davis (general) and W. E. van Heyningen (meetings).

The Association of Southeastern Biologists elected the following officers at its annual meeting, April 14–16, at the University of Tennessee: president, Howard M. Phillips, Emory University; president-elect, Elon E. Byrd, University of Georgia; vice president, Harley B. Sherman, University of Florida; secretary-treasurer, Alvin V. Beatty, Emory University; members of the executive committee, Bruce D. Reynolds, University of Virginia and Dalton M. Brown, East Tennessee State Teachers College. Dr. Phillips was appointed the association's representative on the Council of the AAAS.

The 23rd National Colloid Symposium, sponsored by the Colloid Division of the American Chemical Society, will be held at the University of Minnesota June 6–8. The meeting will be devoted to discussion of five phases of colloid chemistry: proteins, inorganic colloids, membranes, carbon blacks and solubilization, and ion exchange phenomena.

The National Research Council and the Office of Naval Research will jointly sponsor a **Symposium on Wood** which will be held June 16–17 at the National Academy of Sciences. One session of the meeting will be devoted to the requirements of the National Military Establishment; other sessions will cover mechanical, chemical, and biological aspects of wood; a fifth session will discuss marine borers.

The Division of Physical and Inorganic Chemistry of the American Chemical Society will hold a **Symposium on the Solid State** at the Mellon Institute in Pittsburgh June 20–22. William J. Kirkpatrick will be chairman of the meeting, and E. L. Warrick is in charge of housing. Both may be addressed in care of the Mellon Institute.

A Symposium on Light and Living Organisms will be held at the annual meeting of the Society of General Physiologists at the Marine Biological Laboratory in Woods Hole, Massachusetts June 22–24. Further information may be obtained from Professor Arthur K. Parpart, Biology Department, Princeton University.

Meetings and Elections

The New England Section of the Optical Society of America was installed May 5, in Boston. Stanley S. Ballard, secretary for Local Sections, officiated at the installation, and was assisted by two former OSA presidents, Arthur C. Hardy and George R. Harrison. The speech of the evening, "Color Translation and Ultraviolet Microscopy," was given by Edwin H. Land.

The new section, formerly the New England Optical Society, draws its membership largely from the greater Boston area, but meetings are also attended by scientists and students from Rhode Island, Connecticut, New Hampshire, and western Massachusetts.

The newly elected officers are: president, Duncan E. Macdonald, Boston University Optical Research Laboratory; vice president, David S. Grey, Polaroid Corporation; secretary, John T. Watson, Boston University Optical Research Laboratory; and treasurer, Russel P. Mahan, Baird Associates, Inc.

Deaths

Harry T. Edwards, 71, fiber specialist, died May 6 in Washington, D. C. Dr. Edwards, who retired from the Department of Agriculture in 1945 after 28 years of service, was instrumental in introducing manila hemp plantations into tropical America in 1925.

Philip Sidney Smith, 71, geologist, died May 10 at St. Albans, Vermont. Dr. Smith joined the Geological Survey in 1906, and retired as chief of the Alaskan Division in 1946.

John M. Cooper, 69, chairman of the Department of Anthropology at Catholic University, died May 4 of a heart attack at the university. Msgr. Cooper, author of several volumes on North American Indian tribes, was editor of the scientific magazine, *Primitive Man*, and publications of the Catholic Anthropological Conference; the prelate also served on the editorial boards of the *Journal of Social Hygiene* and *Parents' Magazine*.

William W. Hansen, 39, physicist, died May 23 in Palo Alto, California. Dr. Hansen, pioneer in radar research and development, was elected to the National Academy of Sciences and was awarded the Liebman Memorial prize for outstanding work as a radio engineer.

Starring will be temporarily discontinued for the eighth edition of *American Men of Science*. It has been announced by Jaques Cattell, editor, that the growth and integration of all fields of science since the publication of the last edition have made the establishment of an equitable system of starring very difficult. After consultation with the special Committee on Starring appointed by the AAAS, he has decided to leave open the question of starring in future editions of the directory.

A Guide to Russian Scientific Periodical Literature, published by the Brookhaven National Laboratory for the purpose of acquainting English-speaking scientists with the work of the Soviet Union, may be obtained by writing to the Information and Publications Division Brookhaven National Laboratory, Upton, New York. The seven issues published to date include translations of titles of articles in Russian scientific journals, beginning with 1947 when the Russians discontinued the printing of English text in their journals; translated abstracts of papers on physics and nuclear science; complete translation of significant articles in the field of nuclear science, such as the one on cosmic rays by A. I. Alikhanyan; and listings of titles of translated articles available at Brookhaven's Central Repository for Translations of Russian Scientific Articles.

Ruins of stone-and-whalebone houses built by ancient Thule Eskimos on Cornwallis Island in the northern Canadian Arctic Archipelago will be explored this summer. Henry B. Collins, Jr., and J. P. Michea will represent respectively the sponsors of the expedition, the Smithsonian Institution and the National Museum of Canada. The archeologists hope by their excavations at Resolute Bay to establish the relationship between the 500-to-800-year-old Thule culture and that of the Dorset Eskimos, predecessors of the Thules. The village sites may also reveal information about the migration of both groups eastward and northward to Greenland.

Make Plans for—

Symposium on Fine Particles and Resolutions, June 9–10, Stevens Hotel, Chicago.

American Physical Society, semicentennial meeting, June 16–18, Cambridge, Massachusetts.

Institute of Mathematical Statistics, June 16–18, Berkeley, California.

American Society of Medical Technologists, annual convention, June 19–23, Hotel Roanoke, Roanoke, Virginia.

Mathematical Association of America, joint meeting with **Mathematics Division, American Society for Engineering Education**, June 20–21, Rensselaer Polytechnic Institute, Troy, New York.

American Institute of Electrical Engineers, summer general meeting, June 20–24, New Ocean House, Swampscott, Massachusetts.

Heat Transfer and Fluid Mechanics Institute, June 22–24, University of California, Berkeley.

Quantitative Relations in the Physiological Constitutions of Mammals

E. F. Adolph

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THE INVESTIGATION OF VITAL FUNCTIONS customarily ends with the establishment of a relation between process X and process Y. It need not end so; and the object of the present paper is to show how the relations may be multiplied, providing either X or Y is used as a common correlative in further studies.

Most data of physiology concern the rates of processes. The rates represent the events, regardless of the manner in which the processes are performed. By measuring the ordinary events of living in several species, or in several individuals of diverse sizes or activities, the disproportionalities among processes are disclosed. The present description is limited to correlations *among* species and chiefly to data upon mammals. The result illustrates a quantitative method in comparative physiology and in generalized physiology.

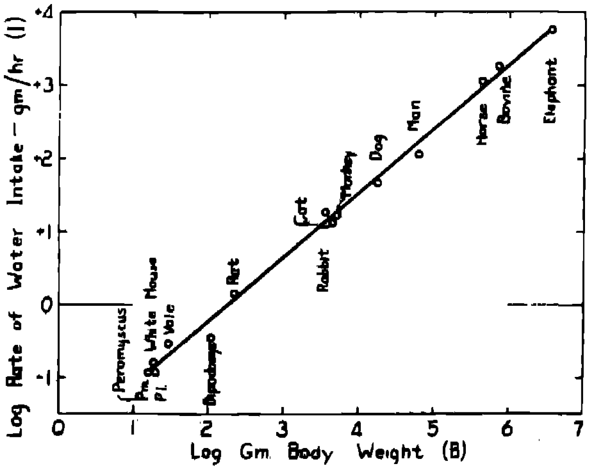

FIG. 1. Rate of water intake (I) in relation to body weight (B) among species of mammals. $I = .010\ B^{.88}$. From Adolph (*1*, p. 270).

In a previous study, rates of water exchanges were correlated with body sizes among mammals (*1*, p. 270). One set of those data is reproduced in Fig. 1. It is evident that logarithms of water intakes (I) are proportional to logarithms of body weights (B). The data fit an equation:

$$I = aB^k \quad . . . . (I)$$

which may also be written:

$$\log I = \log a + k \log B \quad . . . . (II)$$

The coefficients a and k can be ascertained from the graph or by computation of least squares. Such power equations have been widely found to express suitably the regressions between organ sizes, and to a more limited extent to relate rates of oxygen consumption with body sizes (*3*).

The empirical relation of Fig. 1 turned out to be

$$I = .010B^{.88} \quad . . . . . . (III)$$

The exponent means that water turnover (ml/hr) is not proportional to body weight (g); if it were, the exponent would be 1. The larger mammals have, relative to weight, less turnover than the smaller, and many suggestions have been put forward to the effect that rates of diverse processes might be proportional to body surface areas, perhaps to $B^{.67}$, or to other power functions of B. The general form of this equation is referred to as heterogonic; it expresses degrees of disproportionality; it is an equation of similitude. In a group of such equations might be implicit most of the factors by which an elephant differs from a mouse.

From the same source (*1*, p. 271) data are available relating urinary outputs (U) to body weights (B) in mammals. In this case,

$$U = 0.0064\ B^{.82} \quad . . . . . (IV)$$

Evidently urine production is slightly more disproportional to body weight than is water intake. The relation implies that small animals (as compared with large animals) lose a slightly smaller fraction of their water turnover by paths other than urinary excretion; the chief other path of loss is evaporation.

The interrelation can be more clearly expressed by the appreciation of the fact that since I and U are each related to B, they are related to each other. Or, more generally,

$$Y = a_1\ X^{k_1} \quad . . . . (V)$$

and

$$Z = a_2\ X^{k_2} \quad . . . . (VI)$$

or

$$\log X = \frac{\log Y - \log a_1}{k_1} = \frac{\log Z - \log a_2}{k_2} \quad . (VII)$$

then

$$\log Y = \log a_1 + \frac{k_1}{k_2}\ (\log Z - \log a_2) \quad . (VIII)$$

and

$$Y = a_1 \left(\frac{Z}{a_2}\right)^{\frac{k_1}{k_2}} \quad . \; . \; . \; . \; . \; . \quad \text{(IX)}$$

In the specific instance of I and U,

$$\log I = \log .010 + \frac{.88}{.82} (\log U - \log .0064) \quad . \quad \text{(X)}$$

$$= -2.000 + 1.073 \, (\log U + 2.194) \quad . \quad \text{(XI)}$$

or

$$I = 2.25 \, U^{1.073} \quad . \; . \; . \; . \; . \; . \quad \text{(XII)}$$

The inverse of relation IX has the form

$$Z = a_2 \left(\frac{Y}{a_1}\right)^{\frac{k_2}{k_1}} \quad . \; . \; . \; . \quad \text{(XIII)}$$

from which

$$U = .46 \, I^{.93} \quad . \; . \; . \; . \; . \quad \text{(XIV)}$$

and the inverse of relation V has the form

$$X = \left(\frac{Y}{a_1}\right)^{\frac{1}{k_1}} \quad . \; . \; . \; . \; . \quad \text{(XV)}$$

These expressions of quantitative interrelations may be applied to all functions in which log Y is proportional to log Z. Other expressions can be utilized to express interrelations when additional forms of disproportionality may be found.

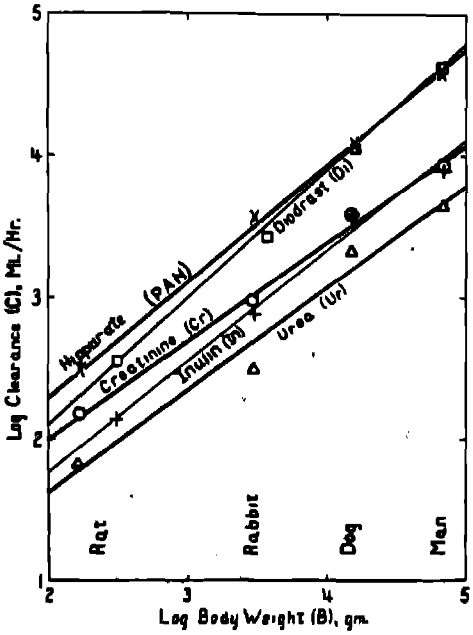

FIG. 2. Renal clearances (C) in relation to body weight (B). Straight lines are fitted on log-log units by least squares from points established for maximal clearances. Rat—Lippman, Dicker, Dicker and Heller (*19*, *7*, *8*). Rabbit—Kaplan and Smith, Forester and Maes, W. W. Smith (*16*, *11*, *22*). Dog—Domingues, Houck, Moustgaard (*9*, *15*, *22*). Man—Hayman *et al.*, Goldring *et al.*, Chasis *et al.* (*14*, *12*, *4*).

Since a great many data of anatomy, biochemistry, and physiology can be shown to fit the heterogonic equation, the fruitfulness of this particular form of relation may be illustrated from them.

Renal clearances, which are measurements of excretory functions, have been ascertained for single organic substances in several species; their magnitudes are related with the body weights of those species (Fig. 2). A clearance is a ratio between a rate of disposal of a substance (g/hr) and its concentration in body fluid (g/ml). The data here represented have been selected by the sole criterion of taking, within each species, the arithmetical mean of that series of measurements giving maximal values for clearance of each substance. Evidently the several substances are not cleared in proportion to the body weight; the equations all have exponents less than 1. There is no support for the guess that all the

TABLE 1

EQUATIONS RELATING QUANTITATIVE PROPERTIES WITH BODY WEIGHTS AMONG MAMMALS*

Intake of water (ml/hr)	I	$=.010\ B^{.88}$ (Fig. 1)
Urine output (ml/hr)	U	$=.0064\ B^{.82}$ (*1*, p. 271)
Urea clearance (ml/hr)	C_{ur}	$=1.59\ B^{.72}$ (Fig. 2)
Inulin clearance (ml/hr)	C_{in}	$=1.74\ B^{.77}$ "
Creatinine clearance (ml/hr)	C_{cr}	$=4.2\ B^{.69}$ "
Diodrast clearance (ml/hr)	C_{di}	$=2.14\ B^{.89}$ "
Hippurate clearance (ml/hr)	C_{PAH}	$=5.4\ B^{.80}$ "
O_2 consum. basal (ml STP/hr)	O	$=3.8\ B^{.734}$ (*6*, p. 370)
Heartbeat duration (hr)	H	$=.000\ 0119\ B^{.27}$ (*5*, p. 69)
Breath duration (hr)	Q	$=.000\ 047\ B^{.28}$ (*18*)
Ventilation rate (ml/hr)	V	$=120\ B^{.74}$ (*13*)
Tidal volume (ml)	T	$=.0062\ B^{1.01}$ (*18*)
Gut beat duration (hr)	G	$=.000\ 098\ B^{.31}$ (*5*, p. 91)
N Total output (g/hr)	N_T	$=.000\ 074\ B^{.735}$ (*3*, p. 377)
N Endogenous output (g/hr)	N_E	$=.000\ 042\ B^{.72}$ (*3*, p. 377)
Creatinine N output (g/hr)	N_{cr}	$=.000\ 001\ 09\ B^{.90}$ (*3*, p. 378)
Sulphur output (g/hr)	S	$=.000\ 001\ 71\ B^{.74}$ (*3*, p. 378)
O_2 consum. liver slices (ml STP/hr)	O_L	$=3.8\ B^{.77}$ (*28*)
Hemoglobin wt (g)	H_b	$=.013\ B^{.99}$ (*10*)
Myoglobin wt (g)	M_y	$=.000\ 030\ B^{1.31}$ (*10*)
Cytochrome wt (g)	P_c	$=.000\ 10\ B^{.84}$ (*10*)
Nephra number	N	$=2600\ B^{.62}$ (Fig. 3)
Diameter renal corp. (cm)	D	$=.0081\ B^{.08}$ (*18*)
Kidneys wt (g)	K	$=.0212\ B^{.85}$ (*3*, p. 625)
Brain wt (g)	E	$=.081\ B^{.70}$ (*3*, p. 592)
Heart wt (g)	J	$=.0066\ B^{.98}$ (*3*, p. 596)
Lungs wt (g)	F	$=.0124\ B^{.99}$ (*3*, p. 627)
Liver wt (g)	L	$=.082\ B^{.87}$ (*3*, p. 626)
Thyroids wt (g)	M	$=.000\ 22\ B^{.80}$ (*3*, p. 621)
Adrenals wt (g)	A	$=.0011\ B^{.92}$ (*3*, p. 585)
Pituitary wt (g)	P	$=.000\ 18\ B^{.76}$ (*3*, p. 596)
Stom. + intes. wt (g)	W	$=.112\ B^{.94}$ (*3*, p. 628)
Blood wt (g)	R	$=.055\ B^{.99}$ (*3*, p. 598)

* Source of equations or data from which equations have been derived are indicated. All values are in ml, g, cm, and hr.

exponents are alike, or, as many physiologists assume, that all are .67. Within one species it may well be that measurement of one clearance foretells all the others; but different proportions evidently prevail within different species. The relations from which such predictions may be formulated are listed in the equations of Table 1; one of them is given as an example in line 2 of Table 2.

TABLE 2

EQUATIONS INTERRELATING SOME QUANTITATIVE PROPERTIES OTHER THAN BODY WEIGHT, DERIVED FROM TABLE 1*

$U = .46\ I^{.\text{[illegible]}} = .0108\ C_{ur}^{1.14} = .000{,}000\ 19\ N^{1.\text{[illegible]}}$
$C_{ur}^{.\text{[illegible]}} = .85\ C_{PAH}^{.90} = 17{,}700\ N_T^{.\text{[illegible]}} = 42\ K^{.\text{[illegible]}}$
$O = 1800{,}000{,}000{,}000\ H^{\text{[illegible]}} = 11{,}900\ P^{.67}$
$V = 370{,}000{,}000{,}000{,}000\ H^{3.14} = 4900\ T^{.\text{[illegible]}}$
$N_T = .0068\ U^{.90} = 5.4\ N_{cr}^{.\text{[illegible]}} = .000{,}0102\ C_{cr}^{1.\text{[illegible]}}$
$O_L = 80\ L^{.\text{[illegible]}} = .61\ O^{1.05} = 1200\ M_V^{.\text{[illegible]}}$

* All values are in ml, g, cm, and hr.

A very large number of relations between physiological rates taken two at a time becomes available. A limited set of data relating each function to body weight (Table 1) allows its relations with other quantities to be expressed in the manner of Table 2 without need for new measurements. Indeed, the relationships once ascertained on several species of diverse sizes will establish a relation that may then be used to describe the relationships established by the study of entirely different species. Thus, the data of Fig. 1 might have been obtained solely from mouse, cat, horse, and elephant; those of Fig. 2 being derived from four other species. Nevertheless the relation between I and C_{ur} would evidently be derived with almost the same degree of determination as by the use of identical species for both measurements.

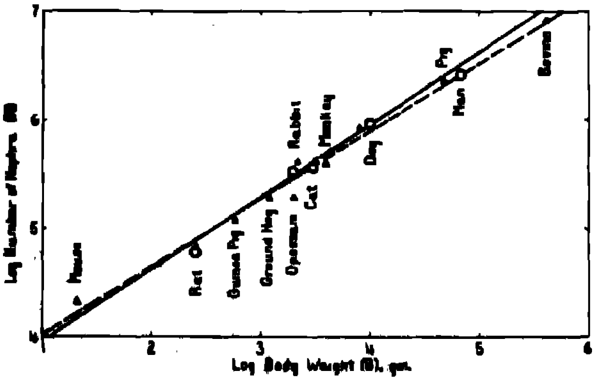

FIG. 3. Number of nephra (N) in two kidneys in relation to body weight (B) among mammals. The solid line ($N = 1900\ B^{.62}$) fits the circles which represent on log-log scales the arithmetical means of counts of glomeruli made by Arataki (*2*) for rat, Nelson (*33*) for rabbit, Vimtrup (*36*) for cat and dog, Moritz and Hayman (*29*) for man. The dotted line ($N = 2600\ B^{\text{[illegible]}}$) fits the triangles, which represent arithmetical means of counts made by Kunkel (*18*).

From the reservoir of data upon numerical relationships of structural peculiarities to body sizes, specifically interesting relations with physiological rates may be derived. For instance, the number of nephra in the kidneys of various mammals have been counted; the numbers relate to body sizes (Fig. 3) with heterogony of low power (.62). Then urinary flow, having a higher power in relation to body weight (.82) has an exponent 1.32 in relation to nephra number. This means that when the number of excretory units is 10-fold as great, the rate of urinary excretion is 21-fold as great. In the bovine each nephron puts out 52 times as much urine as in the rat. The diameters of renal capsules increase only slightly with body weight (exponent .08). However, the volumes of renal corpuscles increase with body weight as the exponent .24. Hence the physiological activity of each nephron turns out to have a markedly different magnitude among species; but each unit of volume of renal corpuscles is about proportional to urinary flow, since

$$ND^3 = a\,B^{.86} \quad . \quad . \quad . \quad . \quad . \quad \text{(XVI)}$$

and each unit of surface,

$$ND^2 = a\,B^{.78} \quad . \quad . \quad . \quad . \quad \text{(XVII)}$$

Similarly, the renal clearance of none of the five substances (for which data are presented in Fig. 2) is proportional to nephra number. A nephron in a bovine, approximately identical in structure with that of a mouse, clears more of each excretory substance. Realization of this fact might lead to extensive search for differences among nephra.

A few data upon rates of excretion of solutes have been analyzed in relation to body weights by Brody (Table 1: N_T, N_B, N_{cr}, S). One fact here discovered is that creatinine excretion is not proportional to creatinine clearance among species.

Correlations among physiological processes need not be restricted to processes that utilize in large part any one organ (kidneys) or any one activity (excretion). It is equally useful to find the interrelations among processes that have scarcely been thought of as being interrelated. To the above excretory processes may, therefore, be related basal oxygen consumption (*3*), duration of heartbeat (*5*), duration of one intestinal contraction (*5*), duration of one breath (*13*), respiratory ventilation rate, and tidal volume. All three of the above durations have the property of being correlated with body weight (Table 1) by low exponents. Their reciprocals (frequencies) are negative correlatives of body weight.

Data are available for intercorrelations with the above quantitative properties, in the rates of oxygen consumption of tissue slices (O_L) obtained from homologous organs of several species (Table 1). Interest has centered in the *fact that these consumptions per unit of tissue weight* vary as negative powers of body weight (*28*), for that fact indicates that the properties by which large animals consume less oxygen per gram of weight are impressed in their tissues even after isolation. Here these relations are expressed in the form

$$O_L = a\,B^k \quad . \;.\;.\;. \quad (\text{XVIII})$$

instead of

$$O_L/B = a\,B^{k-1} \quad . \;.\;.\;. \quad (\text{XIX})$$

Many physiologists are aware that oxygen consumption is proportional (i.e., with exponent 1) to ventilation rate. (Guyton's data [*13*] yield the constant $O = .028\,V$); and some recognize that oxygen consumption is proportional to nitrogen output (Brody's data [*3*] show that $O = 52{,}000\ N_T$). Further, ventilation rate is proportional to nitrogen output ($V = 1850\ N_T$). These three quantities share the exponent 1 in their relations to one another. In a species where one or two of the three are difficult to measure, they may be computed from the third (or from any of the 33 correlatives represented in Table 1).

A number of biochemical correlations may be estimated from extant data. Concentrations of cytochrome *C* diminish with increased body size (*10*) and suggest thereby a basis for lesser oxygen consumptions per unit tissue mass. To date, most biochemical studies have been limited to one species at a time, and little consideration has been given to the known diversities of composition among species and the implications of those diversities. The interspecific relations here derived may now be regarded in turn as definite functions of all the physiological characters mentioned.

Anatomical characteristics may be added to the total picture. Those that possess known disproportionalities to body weight (Table 1) may have their disproportionalities toward one another computed. The interrelations to function may be illustrated in the weights of kidneys, which are definitely not proportional to many of the clearances and rates of excretion presented above. Altogether, from the 33 equations of Table 1 may be derived 33 × 32 or 1056 equations expressing relations between two properties at a time. Those given in Table 2 are only a few samples. Each of the 1056 has an inverse equation XV.

Alternative sets of data that may confirm any of the above equations are few. For basal oxygen consumptions, the equation $O = 3.8\ B^{.72}$ is computed for rodents of 11 species from data of Morrison (*21*). Weights of seven visceral organs have been analyzed from 20 species of ungulates of diverse sizes by Quiring (*24*), which could replace the corresponding equations of Table 1. Among these seven organs only brain and heart had significantly different (smaller) coefficients than among the corresponding organs analyzed by Brody (*3*). With sufficient measurements it might be, as Morrison's data (*21*) suggest, that diverse orders of mammals will have diverse coefficients of regression in biocorrelations of their properties. It might also turn out that taxonomic orders based upon physiological properties will not segregate species in the same groupings as they are assigned by taxonomists.

There is no reason other than nonavailability for limiting the data mentioned to the physiological properties of mammals. Beginnings have been made in gathering data concerning the oxygen consumptions of diverse crustacea (*29*) and mollusks (*27*) and for water exchanges of aquatic animals generally (*1*, p. 272), as related to body sizes. It must be recognized that no limitation is imposed, by anything but the time and effort of investigation, upon the range of organisms and upon the array of properties that may be considered in interrelations.

A similar analysis may be applied to the changes (growth) in functions during the successive ages of organisms of any one species, or within any one individual.

The fact that all of the properties listed in Table 1 are equally related one to another can be made explicit by means of an alignment chart (Fig. 4). Each vertical scale was constructed by substituting integer values of log *Y* in each of the equations of Table 1. A horizontal line connects all values that belong together. There is nothing unique about body weight or any other single correlative, except that body weight happens to have been measured in gathering all the original measurements. From this chart, the characteristics of a mammalian organism, such as a cat, can be ascertained with fair precision through a knowledge of any one quantitative characteristic of it. The chart also permits comparisons to be made between any two or more species, as between cat and mouse. One would note, for instance, the great ratio of tidal volumes (*T*) of the two species, but the small ratio of breath durations (*Q*). Insofar as mean data can be utilized to describe a species, this chart is valid. For species not yet investigated, predictions are furnished by it. It allows of a probable reconstruction of the characteristics of species now extinct.

Some physiologists will hesitate to extrapolate from the data upon which the equations of Table 1 and the scales of Fig. 4 are based. A few will also hesitate to interpolate in certain zones.

Fig. 4 condenses an enormous amount of information and inference about mammals, since it represents not only 34 biological characteristics in potentially hundreds of species, but also the interrelations among all of them. The appreciation of the myriads of diverse interrelations cannot be made explicit here.

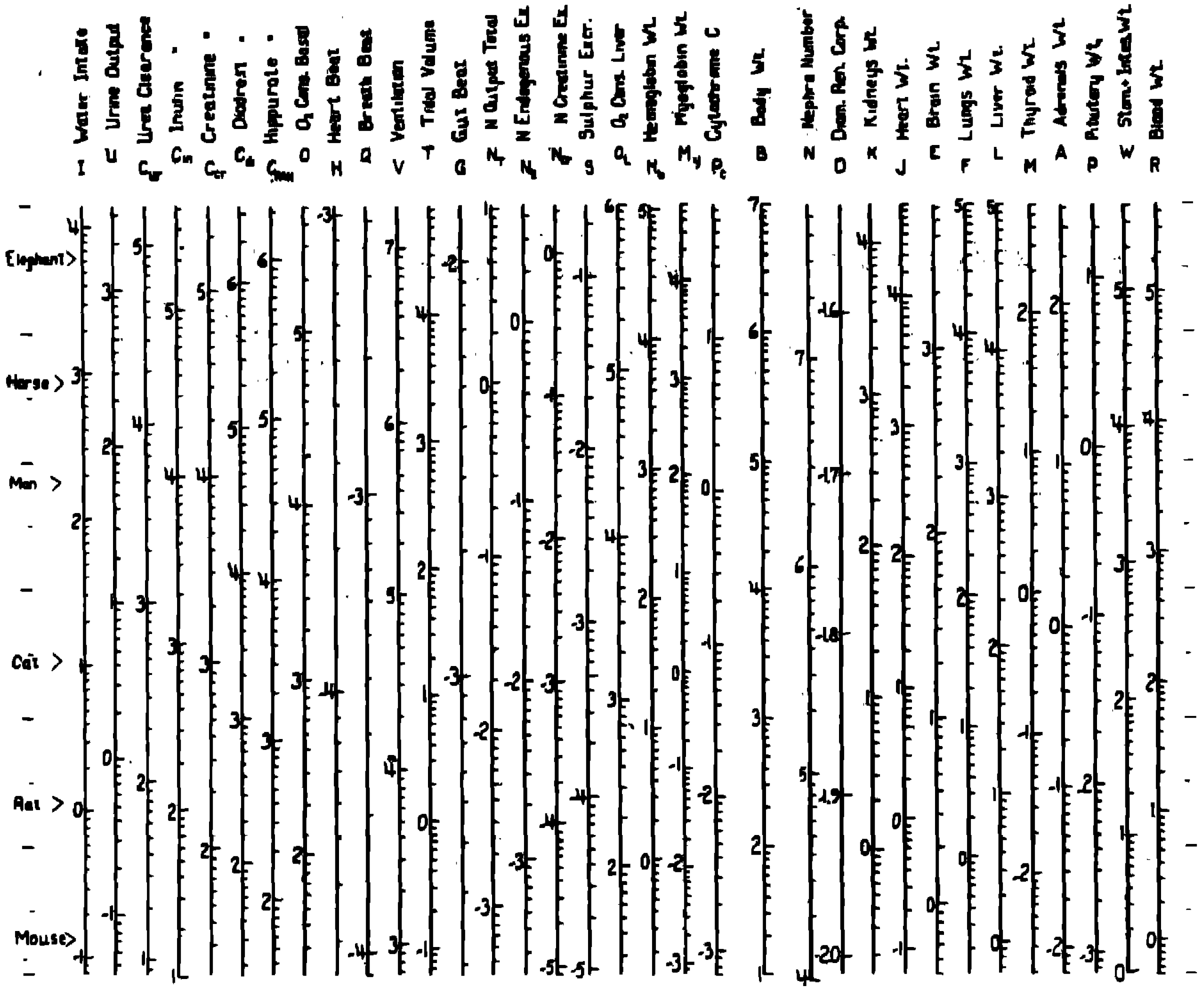

FIG. 4. Alignment chart exhibiting the relations among 34 properties of mammals. The characteristics of one animal are read off along a horizontal thread or ruler that is placed at a known value in any one of the variables. Several species chosen at random are indicated on the left at their appropriate scale positions. Ordinates are numbered as exponents of 10; but the subdivisions between ordinates read arithmetically. Thus, the number 1 means 10^1 and the subdivisions above it mean 20, 30, 40, etc. All values are in ml, g, cm, and hr, as shown in Table 1. The lines and scales represent and are derived from, the equations of Table 1.

Coefficients of correlation between diverse properties are best computed not from intraspecies means but from single measurements. The correlation coefficients (r) found among some of the functions here named are high; many for instance are 0.95 (see Brody, *3*). The corresponding coefficients of determination (r^2) are therefore 0.90; or in ordinary parlance, process X goes with Y to the extent of 90 percent. The high "determination" is not exclusive, and many other processes are equally highly correlated with both X and Y. The remaining 10 percent allows plenty of latitude for those species peculiarities that are not related heterogonically.

Many physiological properties go hand in hand with one another; their "determination" is reciprocal and not unique. It seems likely that an organism is an integrated system by virtue of the fact that none of its properties is entirely uncorrelated, but that most are demonstrably interlinked; and not just by single chains, but by a great number of crisscrossed linkages.

General comment. The heterogonic or power equation is only one of many conceivable equations which might be empirically found to express the regressions between rates of physiological processes. Among organ sizes and biochemical constituents, however, it is the only one that has been found to apply to a large number of relations. The only interspecies data that have been shown not to fit precisely this equation are a few of the extensive data upon brain weights (*6*). Since so many properties have been found to be adequately interrelated by equations of one form, it seems very unlikely that other properties would be related according to a radically different type of equation. For if they were, they would be incompatible with the properties reviewed above. If, however, equations of greater complexity should become necessary to fit new data, the more cumbersome algebra required might impede the study of quantitative interrelations. Whether the heterogonic or some other form of relation between properties prevails does not alter the concept that interrelations may be usefully expressed by equations. The basic assumption in the procedure illustrated is that, among properties common to organisms under comparison, quantities related to a common quantity are related to one another.

Among the heterogonic relationships that prevail among processes, a variety of exponents is found. By tradition, physiologists appear to be conditioned to regard those exponents with certain numerical values more highly than other values. Some persons feel familiar only with exponents of value 1. Others assume that processes in general will reveal exponents in relations to body weights of .67. Empirical considerations have led still others (*17*) to note the prevalence of values about .75. Relations having exponents below 1 will ordinarily be counterbalanced by other relations having exponents above 1. Perhaps most exponents interrelating processes will group themselves in a frequency distribution about the value 1.

Some properties are known to be independent of body sizes (e.g., basal alveolar pressures of carbon dioxide). They are nonetheless connected with properties (such as basal ventilation rates) that are dependent upon body sizes among species.

For every heterogonic exponent below 0, its reciprocal is obviously above 0, and of the same numerical value: that is

$$\frac{1}{Y}=\frac{X^{-k}}{a} \quad . \; . \; . \; . \; . \; . \; . \quad (\mathrm{XX})$$

For every negative exponent, then, some related quantity has a positive exponent. Thus, the reciprocal of heartbeat frequency is beat duration. Only by thinking of those two measurements as separable can anyone suppose that the exponent for the frequency is more "important" than the exponent for its reciprocal, the duration.

Use of the heterogonic equations in as general a manner as they are here applied is justifiable from the aspect of their dimensions because the coefficient a takes its dimensions from those of Y and X. Since the equations were derived empirically the relations found are valid and useful no matter what dimensions they contain.

This consideration suggests a further point, namely, that the equation $Y = aX^k$ may be regarded as the algebraic relation between two simultaneous exponentials such as

$$Y = be^{-\beta t} \text{ and } X = ce^{-\gamma t} \quad . \; . \; . \; . \quad (\mathrm{XXI})$$

In these equations the time t is concurrent in both, e is the base of natural logarithms, and b, β, c, and γ are constants. Then

$$k = \beta/\gamma \text{ and } a = b/c^{\beta/\gamma} \quad . \; . \; . \quad (\mathrm{XXII})$$

Each equation XXI represents a separable process in time.

Relations expressed by heterogonic equations have often been pictured in terms of special physical inferences from exponents. Substances, dimensions, flows, forces, may perhaps be partitioned in a regular manner. Exponents in the equations express the partitions found, and free the observer from the restriction of confining his descriptions to those partitions that are proportional. Sometimes limiting factors have been conceived for these flows and forces, and specifically in terms of enzyme concentrations or other special controls. For those persons more descriptively minded, it suffices to recognize the orderly relations among quantitative characteristics. There are numerous cases where nothing is known of limiting or other governing factors. Organisms can at least be described as systems of multiple interrelations, of orderly disproportionalities. Could it be that heterogony expresses a major aspect of the ground plan of functional and of structural constitutions?

In summary, interrelations are derived, by use of the heterogonic equation $Y = aX^k$, from specific data representing the rates of particular physiological processes. The exponent k expresses the relative rates of X and Y as found by measurements, and for purposes of illustration data available for mammals of diverse species have been analyzed. The interrelations found imply quantitative orderliness among characteristics so diverse as urinary flow, renal clearance, duration of heartbeat, and oxygen consumption. Organisms may be pictured as systems of precise multiple interrelations. These interrelations apply not only to rates of physiological processes, but also to sizes of organs, numbers of reduplicated structures, and biochemical compositions. Some 34 correlatives in mammals are presented nomographically so that from a measurement of any one property the 33 others can be read.

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Detail and Survey Radioautographs[1]

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QUASI-MICROSCOPIC TECHNIQUES in radioautography have left much to be desired in the study of the cellular distribution of radioactive elements and labeled compounds (*19*). The introduction of nuclear track emulsions in radioautographic techniques (*8*) has brought with it the possibility of studying localization of radioactive substances at oil immersion magnification. Alpha tracks have been studied at high magnification (*1, 8*) in conjunction with soft tissue sections mounted on the emulsion (*8, 9*). The localization of beta emitters has been studied at high magnification in tissue sections and blood smears (*5, 6*). The principles of radioautographic technique have been reviewed recently (*1, 4, 10, 11*) and techniques for special purposes have been described (*3, 5, 13, 14, 17*).

The much used *survey* or *contact* type of radiograph (*2, 12*) illustrated in Fig. 1 is indispensable for a study of the gross distribution of radioactive materials. This figure shows the distribution of plutonium in the tibia of a young rat. The section was cut unsoftened (*15*) at 10 μ. The survey examination, however, gives only the gross picture and does not reveal directly the detailed localization of this heavy metal.

A *detail* radioautograph is equally indispensable. Its application to bone is seen in Fig. 2, which was prepared by mounting a second thin section of the tibia on nuclear track emulsion. The detail radioautograph makes it possible to determine the localization of plutonium with respect to cells.

The interpretation of a detail radioautograph depends upon the determination of the point of origin of the emission. Although this is far more easily accomplished for alpha particle emitters, as in Fig. 2, much information may be obtained by examining at high magnification a beta particle sensitive nuclear track emulsion (*5, 7*). A description of the types of nuclear tracks is given by Powell and Occhialini (*18*).

Nuclear particles leave their points of origin in the tissue and travel in random directions. About half of the particles enter the emulsion and strike silver grains. The series of grains in a single path, when developed, reveal a nuclear track (A, Fig. 2). The mean free path is determined by the type and energy of the emission. Thus, the track can be retraced towards the locus in the tissue from which it origi-

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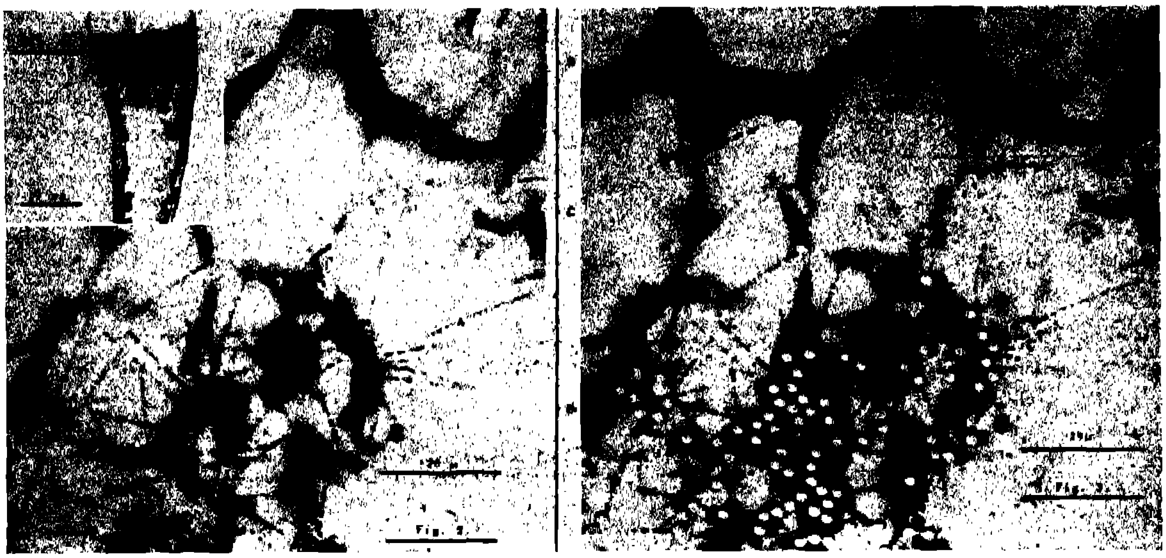

Section of tibia of 9-day-old Wistar rat, 16 g, injected intraperitoneally at 7 days of age (approx. 10 g) with 5.9 µg plutonium as citrate. Ten-µ sections of unsoftened bone (Rat 13; spec. 183; embedded in nitrocellulose, R.S. ½ sec). Fig. 1 shows a *survey* radioautograph, by contact with Eastman ultra-speed dental X-ray film, exposed 81 days. *A*—indicates area of the *detail* radioautograph. (Pl. 001494.) Fig. 2 shows a *detail* radioautograph, tissue section mounted on Eastman NTA plate, exposed 7 days. *A*—Alpha track (tissue end in focus); *B*—zone of vesicular cartilage cells (tissue plane out of focus); *C*—zone of eroded cartilage cells; *D*—primary spongiosa. (*Plate 063*; stained with hematoxylin eosin; Bausch and Lomb Ampliplan 6, Zeiss oil immersion apochromatic 60; extension of camera 50 cm.) Fig. 3 shows localization of plutonium, in the *detail* radioautograph of Fig. 2, marked by placing map tacks at the tissue end of each nuclear track. Note the orderly distribution of plutonium as against the apparent haphazard arrangement of tracks seen in Fig. 2. (Pl. 001496.)

nated by focusing up and down with the fine adjustment of the microscope at high magnification. For purposes of orientation the points of origin may be marked on an enlarged photomicrograph with map tacks. As marker after marker is placed at the beginning of the tracks the pattern of localization of the radioactive substance can be visualized. The orderly localization of plutonium in the region of the zone of eroded cartilage cells of the tibial epiphysis is shown in Fig. 3.

Outlines of survey and detail radioautographic techniques are given in Table 1. The necessity for the use of pressure to insure intimate contact between tissue and emulsion for *survey* radioautographs has been demonstrated by Sherwood's studies (*20*) of microradiographic technique. Nitrocellulose sections are mounted on nuclear track plates by carrying a flat section wet with approximately 75 percent alcohol on a section lifter to the emulsion. The water and alcohol render the gelatin surface sticky enough to hold the section securely throughout processing. The section is quickly covered with filter paper (Whatman's No. 1) and the excess alcohol is taken up by moving a tissue roller back and forth over the plate. The nitrocellulose is immediately removed by repeated flooding with ether-alcohol.

Selection of the emulsion is greatly simplified by an understanding of the functions of the survey and detail radioautographs. For survey radioautographs large grain size is not objectionable. Even the shortest tracks, such as those from an alpha particle, may

TABLE 1

OUTLINE OF RADIOAUTOGRAPHIC TECHNIQUE

	Survey radioautograph	*Detail* radioautograph
Mount:	*Contact* *Mount* tissue on microscope slide (stain after radioautographic exposure). *Place* film against tissue. *Wrap* appropriately to prevent scatter to next film. *Clamp* between glass slides with two 7-lb paper clamps. *Expose* in box, painted black inside and out (*5*).	*Mount tissue on emulsion.*
Emulsion:	*Fast X-ray film.*	Alphagraph: Alpha or beta sensitive *nuclear track emulsion.* Betagraph: Beta sensitive *nuclear track emulsion.*
Exposure:	*Estimate* exposure time from experience with comparable material.	Approximately ⅙ exposure time of survey radioautograph.

radiate a distance of 20 μ. Thus, the total width of the radioautographic image of a point source of alpha particles may be as great as 40 μ (*4*). For beta emitters the images will be much wider (*4, 16*). Therefore, since the fastest emulsions have a grain size sufficiently small to show all the detail possible by the contact radioautographic technique, the selection of an emulsion is determined by the emulsion speed desired. Fast X-ray films offer the advantage of the shortest possible exposure time for survey radioautographs. *Processing* of the emulsions must be carried out according to the manufacturers' recommendations.

In summary, radioautographic examination of thin tissue sections is accomplished by two complementary procedures. Survey radioautographs may be obtained by the well-known method of pressing the tissue, mounted on a glass microscope slide, in contact with a fast X-ray emulsion. Detail radioautographs for examination at high magnification under high dry and oil immersion objectives may be obtained by recently announced methods in which the section is *mounted directly on a nuclear track emulsion.*

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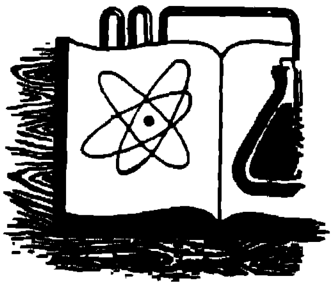

TECHNICAL PAPERS

A New Group of Plant Growth Regulators

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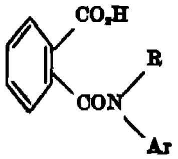
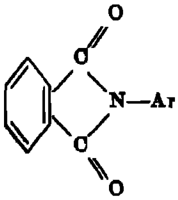
A new group of plant growth regulating chemicals, the N-aryl phthalamic acids, has been discovered. These compounds, which are readily prepared from phthalic anhydride and aromatic amines, can be represented by the general formula I. The esters, amides, and soluble salts of these acids, as well as the N-aryl phthalimides (II) have been found to possess similar activity.

I



II



Where R is a hydrocarbon radical or a hydrogen atom, and Ar is an aromatic group.

The nature and degree of the growth response shown by plants treated with these chemicals depend on the type and age of the plant, and on the concentration and identity of the phthalamic acid derivative used. Data from a field test in which Bonny Best tomato plants having from one to three unset blossom clusters were treated with compounds of this group show the effects obtained (see Table 1). Each plant was sprayed with 100 cc of a solution containing one drop of a commercial wetting agent (Emulphor EL) per 100 mg of chemical used.

TABLE 1

N-aryl phthalamic acid Aryl group	Approximate minimum concentration in ppm to cause:		
	Chemical fruit set	Formative effect	Pronounced inhibition of fruit set
2-Chlorophenyl	63	20	632
2,5-Dichlorophenyl	63	200	632
2,4,5-Trichlorophenyl	63	632	632
3-Chlorophenyl	63	632	632
4-Chlorophenyl	63	632	200
4-Bromophenyl	200	632	632
o-Tolyl	200	632	2000
4-Nitrophenyl	200	2000	2000
3-Nitrophenyl	632	2000	*
2-Hydroxyphenyl	632	632	*
m-Tolyl	632	632	*
p-Tolyl	2000	200	*
Phenyl	2000	*	*

* The effect was not produced at 2000 ppm, the highest concentration tested.

It will be seen that the active concentrations of different compounds vary greatly. A general pattern of response, however, is evident. At low concentrations fruit set is stimulated, and seedless tomatoes are often produced. A morphological response involving a broadening of the leaves is usually evident. This formative effect does not appear to injure the plant seriously; in fact, in some cases the test plants actually seemed to be more vigorous than the unsprayed check plants.

As the concentration of chemical is increased, the formative effect becomes more pronounced. Fruit set is inhibited, although the fruits which are formed may be seedless. Fruit set may be greatly diminished at concentrations which do not decrease vegetative growth.

At still higher concentrations (about 2000 ppm) tomato plants are definitely injured, although seldom killed, by the more toxic compounds. Even at 2000 ppm, however, many of the fruit-setting chemicals cause no apparent injury. In all of these experiments the whole plant was sprayed; no effort was made to confine the spray to blossom clusters.

The effects of N-1-naphthyl phthalamic acid differ from those of other members of the series. At 0.1 ppm it causes a leaf roll, at 0.31 ppm epinasty, and at 20 ppm stem swelling (greenhouse data). In the field test it completely inhibited fruit set at 20 to 2000 ppm. The vine weight was almost normal at 20 ppm (the lowest concentration tested) but epinastic and morphological effects were severe.

N-aryl phthalimides behave much like the corresponding phthalamic acids. Compounds derived from secondary amines (formula I, where R is a hydrocarbon radical) are less active than the corresponding compounds in which R is a hydrogen atom.

Maleic Hydrazide, a Unique Growth Regulant

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Maleic hydrazide has been found to have a pronounced, but temporary, inhibiting effect on plant growth. The length of inhibition period appears to be directly proportional to the concentration used. To our knowledge this effect is unique in that growth inhibition is obtained with little visible harm to the plants.

Maleic hydrazide, or more properly, 1,2-dihydropyridazine-3,6-dione, has the following structure (*1*):

gest that this antibiotic may be effective in extra-intestinal amebic infections such as hepatic abscess as well as in amebic colitis and amebic dysentery.

Eleven cases have since been successfully treated, with no recurrence of symptoms.

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Studies on Arthropod Cuticle. III. The Chitin of Limulus[1,2]

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Through the years there has been sporadic discussion as to whether or not the chemical chitin is a single compound, identical in all animals and fungi. The consensus of opinion, based on the chitosan color test, nitrogen values, and X-ray diffraction diagrams, is that it is a single compound in the sense that it is always a polymer of identical acetyl glucosamine units (*1, 3*). However, some exceptional cases have been recorded that require further investigation. The outstanding exception within the phylum Arthropoda is the cuticle of the horseshoe crab, *Limulus polyphemus*. Fränkel and Jellinek (*4*) isolated and identified glucosamine crystals from *Limulus* that were identical with similar preparations from ordinary crab shells, but their chitin preparation had a low nitrogen value (5.51% in contrast to 6.89% theoretical for acetylated glucosamine). On the basis of analyses giving a carbon-nitrogen value of 10 to 1 (in contrast to 8 to 1 for ordinary crabs) they postulated that the chitin of *Limulus* is made up of units similar to those in chitin from other arthropods, but that there is an additional ethyl or two methyl groups substituted somewhere in the units which, like the acetyl group, are hydrolyzed off during the preparation of glucosamine. To make this suggestion one has to assume that the alkali purification is reasonably complete (since chitin, having no known solvent, cannot be purified by recrystallization).

Reinvestigation of this question has led us to the conclusion that the purification procedure is at fault. Our first nitrogen analyses of alkali-purified chitin from *Limulus* were comparable to those of Fränkel and Jellinek; however, using a more complete purification process involving prolonged treatment with an oxidizing agent ($KMnO_4$ followed by $NaHSO_3$) after the treatment with hot alkali (*2*), we have obtained a pure white residue which gives a Kjeldahl nitrogen value of 6.06%. This, although significantly higher than the value recorded by Fränkel and Jellinek, is still considerably lower than the nitrogen values of chitin purified from the cuticles of other arthropods. It is suggestive of the removal of additional impurities, but is inconclusive, since chitin is not completely resistant to hot alkali. In an attempt to settle the point, we had X-ray diffraction pictures made of chitin purified from the cuticle of *Limulus* and from a local species of crayfish (*Cambarus* sp.).[3] The X-ray pictures are identical, and agree with those previously published for chitin (*2, 3*). We are forced to conclude that the chitin units of *Limulus* are not substituted in the manner suggested by Fränkel and Jellinek and that they are almost certainly identical with those found in the cuticles of other arthropods. Probably differences do occur on the polymer chemical level (*5, 6*), but on the constituent unit level the substance appears to be the same for all arthropods.

This finding necessitates a reconsideration of the chemical components of cuticle. As we have pointed out previously (*6*), there is no assurance that anyone has ever prepared pure chitin. Since, unlike cellulose, chitin is not known to occur in any approximation to the pure state (usually less, commonly much less, than half the dry weight of the cuticle) and since no solvent for it is known, all assumptions of purity have been based on inconclusive data. For another component to be present in the extracts studied would require only that it agree with chitin in being insoluble in and not destroyed by treatment with water, weak acid at room temperatures, hot or cold alkali at any concentration for short periods, strong oxidizing agents at room temperatures, and ordinary organic solvents, and that it be present in low enough percentage not to greatly disturb the nitrogen values. It must also be either amorphous or of nearly identical lattice spacings or else the amount present in *Limulus* chitin would be detectable in the X-ray diffraction pictures.

Accepting the idea that chitin is made of the same units in all arthropods, the discrepancies between theoretical and actual nitrogen values presumably represent unremoved components of the cuticle. If we assume that the unknown component contains no nitrogen[4] we can make preliminary estimates of the amount present based on the nitrogen determinations. Considering only some of the recent values, we have 6.6% N for lobster chitin (*2*), 6.45% N as an average figure for insect chitin with 6.28% N as the low value obtained from hardened puparia (*3*), and 6.06% N as the highest value obtained by us for *Limulus* chitin. Calculating on the basis of 6.9% N representing pure chitin, we obtain the following degrees of purity for materials studied by these authors: lobster 96%, average insect 94–95%, hard puparia 91% and *Limulus* 87% (the material used by Fränkel and Jellinek being only 80% pure).

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[1] Paper No. 2447, Scientific Journal Series, Minnesota Agricultural Experiment Station, St. Paul.

[2] The work described in this paper was done under contract between the Medical Division, Chemical Corps, U. S. Army and the University of Minnesota. Under the terms of this contract the Chemical Corps neither restricts nor is responsible for the opinions or conclusions of the author.

[3] X-ray patterns made by Dr. W. N. Lipscomb, of the Chemistry Department.

[4] The unknown component cannot contain more nitrogen than chitin does, and if it contains any nitrogen then the contaminant percentage will be even higher than these calculations.

We conclude that Fränkel and Jellinek's suggestion of a substituted chitin is incorrect and that *Limulus* almost certainly contains the same chitin units as other arthropods. Accepting this, it follows that all so-called pure chitin used for analytical work contains at least several percent of an unknown contaminant, that in hardened cuticles this may be over 5%, and that in *Limulus* it is considerably more than 10%. The identity of the contaminant is at present only a matter of conjecture. It would be of considerable interest to know whether it is an as yet unrecognized compound[2] or a percentage of one of the known components that is so strongly bound to the chitin that it is not removed by the purification procedure.

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Temperature Measurement inside the Body Using a Thermistor[1]

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In recent years thermistors have been increasingly applied to the measurement of temperature in animal and man (*1, 3*). A thermistor has three important advantages over a thermocouple for measurement of temperature in the body. Due to its high temperature coefficient (−3%/° C) it is approximately ten times as sensitive as a thermocouple, assuming the same order of sensitivity of detecting device. Because of its high impedance (several thousand ohms as compared to a few ohms) lead resistances and switch contact resistances are relatively unimportant; so it is not necessary to take special pains in the wiring of associated circuits. Finally, there is no necessity for maintaining a constant reference temperature.

For these reasons it was decided to incorporate a thermistor as the sensitive element in fine catheters for measuring temperatures inside the animal body. One type of catheter for measuring the temperature inside joint spaces and muscles (*2*) consisted of a radio-opaque plastic tube 0.063 cm OD, 0.036 cm ID, varying in length from 15 cm to 1.5 meters. Catheters of larger diameter have also been made for intracardiac and intravascular observations. The thermistor was placed flush with one end, the lead wires coming out the other end.

The thermistor used for this application was Western Electric Type V597 having the following characteristics:

Diameter	0.4 mm
Temperature coefficient at 38° C	−3.1 %/° C
Dissipation constant (in still air)	0.1 mm/° C
Thermal time constant (in still air)	1 sec.

Since it was supplied with two 0.025-mm bare platinum leads 8 mm long, it was necessary both to splice these wires to a pair of copper leads, and to insulate the platinum wires and spliced junctions from each other. No. 40 enamel covered copper wire was used for the lead.

TABLE 1

Temperature Measurements in the Dog*

	°F
Superior vena cava	98.9
Coronary sinus	99.0
Right ventricle	99.0
Pulmonary artery	98.8
Inferior vena cava	98.6
Hepatic vein	98.0
Renal vein	98.4
Azygos vein	98.6
Femoral vein	99.9
Femoral artery	98.0
Thigh muscle (2 in.)	99.5
Thigh surface	92.8
Rectal	99.1

* Room temperature 73.0° F.

A connection was effected by wrapping two turns of the platinum wire tightly about the copper lead. A conducting silver paste was then applied to assure satisfactory electrical contact. In order to insulate the two platinum wires from each other, a very fine rayon thread was wrapped tightly along each wire beginning at a point on the copper wire a little below the junction. The whole assembly was then dipped into a bakelite solution, care being taken not to immerse the thermistor bead itself. After the bakelite had been baked, the whole assembly was threaded through the plastic tubing. The end containing the thermistor was then sealed with a small amount of polystyrene, care again being taken not to coat the thermistor bead which protruded a few tenths of a millimeter beyond the end of the tube.

The unit was connected into a conventional Wheatstone bridge using a Rubicon galvanometer of sensitivity 0.007 μa/mm as an indicating instrument. For recording purposes, the output of the bridge was connected to a pen-writing oscillograph. The overall accuracy of the device was ±0.05° C.

Vascular and other temperatures obtained with the thermistor units are shown in Table 1. The dog was under heavy Nembutal anesthesia. The catheter was passed through the right external jugular vein, and its position was recognized roentgenoscopically.

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[1] Aided by a grant to the University of Pennsylvania from The National Foundation for Infantile Paralysis.

[2] The possibility of another type of substituted glucose chain with a side group that would give the same lattice unit dimensions as an acetylated amine group is conceivable.

Similar temperature data have been obtained in various human joints. A 19-gauge hypodermic needle was inserted into the knee joint space. The catheter was threaded through the needle and the needle withdrawn, leaving the thermistor unit in place within the joint. The knee joint temperatures of two normal adult males were found to be 90.3° and 91.2° F respectively, while the surface or skin temperatures were 84° F.

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A Comparative Study of Oyster Condition[1]

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The necessity of providing an objective evaluation of the condition of oysters in ecological investigations has long been recognized by workers in this field. The condition index originally proposed by Hopkins (*1*), which depends upon the measurement of the ratio of dry meat weight to internal shell volume has not been entirely satisfactory for this purpose. Many workers have found considerable variation in this index among oysters from the same region, even where the condition of meat by visual comparison appeared to be relatively constant.

For this reason later workers have adopted the measurement of glycogen content as a supplementary method of evaluation (*2–4*). Since this method appears to yield more consistent results, a study was carried out to determine correlation between condition index and glycogen content.

In all, 30 samples of oysters from various habitats of the Louisiana oyster bayous and four samples from the outside tanks of the U. S. Fisheries Station, Pensacola, Florida, were taken, and each sample was analyzed by both methods.

In arriving at condition index a 10-g aliquot of the ground oyster tissue from 10 oysters was dried at 80° C for 48 hr and weighed. After 15 min in the air it was again dried and weighed to constant weight ±.005 g. The dried weight of the 10 oysters was then calculated and entered into the formula:

$$\frac{\text{Total dry weight in g} \times 100}{\text{Shell cavity volume}} = \text{Index of condition.}$$

Shell cavity volume was obtained by water displacement.

Five to 10 g of the same sample of ground oyster meats was digested and the glycogen was hydrolysed by the Calderwood-Armstrong method (*5*). The Hagendorn-Jensen technique (*6*) for the quantitative determination of glucose followed. To insure against enzymatic action, not more than 3 min was permitted to elapse between grinding the meats in a Waring blender and the digestion of the aliquot in sodium hydroxide.

Fig. 1 shows the correlation between the findings of the two methods. Closer correlation appears to exist among animals of the higher glycogen content and presumably greater vigor. In fact, the correlation coefficient of .69 for the entire group is reduced to .38 if the three samples highest in glycogen are omitted.

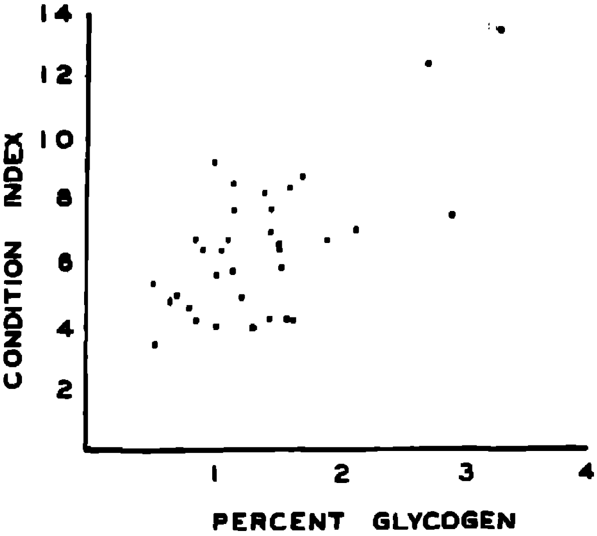

Fig. 1.

It is concluded from these preliminary studies that the poor correlation between the two methods in oysters of low vigor is probably due to dependence of the condition index upon water content, absolute size of meats, and other factors. Because of this, it is believed that glycogen analysis is the most suitable method for the comparison of work carried out by independent investigators on low quality oysters. Further work is under way to determine if a significant correlation exists between the two methods in high quality oysters.

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[1] Facilities and support for this investigation were supplied by the Department of Wildlife and Fisheries of the State of Louisiana.

[2] The author is indebted to Drs. F. G. Walton Smith and H. Malcolm Owen for advice and to Louis A. Bregan, Jr., for technical assistance.

Maximal Consumption of Ethyl Alcohol

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Physicians who have had to deal with patients suffering from chronic alcoholism cannot but have been impressed with the wide variation in estimates given by them when asked how much they drink daily. In general, they fall into one of two classes: those who state that they never take more than a couple of beers, and those who stoutly maintain that they consume up to 2 qt of whisky every 24 hr. In order to have some basis for judging the credibility of these statements, it would be desirable to know with a fair degree of accuracy the maximum amount of alcohol that can be consumed daily over a period of several days.

Simple as the direct experimental approach to the problem would seem to be, the medical literature fails to record such an experiment. In default of such direct appraisal, which should certainly some day be made, there is available a sufficient amount of data bearing on the subject to allow us to estimate the maximal daily intake with a reasonable probability of accuracy.

Widmark (*7*) estimated, on the basis of the rate of fall of blood alcohol concentration after a single dose, that a 70-kg man should be able to dispose of 170 g of alcohol in 24 hr, which would imply a rate of alcohol metabolism of 101 mg/kg/hr. If Widmark's estimate is accurate, we must conclude that the greatest amount of 100 proof whisky that a man of average weight could metabolize in a day would be 14 oz, or less than a pint, which would certainly render inaccurate the estimates frequently given of a consumption several times this great. Nor can it be argued that the greater capacity claimed by addicts may be due to increased facility in alcohol metabolism engendered by habituation, for this has been found not to be the case (*3*).

Before we prematurely discredit the patients' statements, however, we must consider an important factor which probably operated to make Widmark's estimate too low. This is the finding, recently confirmed (*1, 4*), that the rate of alcohol metabolism is not constant irrespective of dosage, as Widmark believed, but that it increases with increasing blood alcohol concentration. Thus Eggleton (*1*) found by referring back to Mellanby's original work (*8*) that in the dog, when the blood alcohol concentration was between 300 and 400 mg/100 cc, the rate of alcohol metabolism was 200 mg/kg/hr; whereas when the concentration was between 200 and 300 mg/100 cc, the rate was only 150 mg/kg/hr. Similarly Newman and Lehman (*5*) found that, considering the average for four dogs, an increase in dosage of 100%, which would double the average blood alcohol concentration, produced an increase in rate of alcohol metabolism of 36%. This has since been confirmed by Newman, Yee, and Cutting (*6*). Since most of Widmark's work was done with small doses of alcohol, the increase in rate of metabolism with increasing dosage may well be responsible for the low estimate of maximal daily consumption reported by this generally reliable worker.

That maximal daily consumption is indeed higher than that put forward by Widmark is supported by the amount of alcohol that has been consumed day after day by dogs in this laboratory. Thus three dogs were allowed access at all times to a solution of 5% by volume of ethyl alcohol in tap water as their sole source of fluid. Under these circumstances they consumed alcohol at a rate of 4.46 g/kg/day. When the percentage of alcohol was raised to 10% they reduced their fluid intake accordingly, so that their alcohol intake increased only to 5.52 g/kg/day. This is equivalent to 230 mg/kg/hr, which is quite a close approximation to the 200 mg/kg/hr that was found by Mellanby with high alcohol dosage. If we transpose this to man, the maximal daily dosage for a 70-kg man can be calculated to be 386 g of alcohol, or approximately 32 oz of 100 proof whisky. This is much nearer the intake claimed by many alcoholics.

A reasonable criticism of the above inference is that so far no evidence has been put forward to justify equating the rate of alcohol metabolism in dog and man. There is, however, fairly conclusive evidence that such an equation is tenable. Thus Newman and Lehman (*5*) found as the average for two human subjects after a dose of 1.5 g/kg, a rate of metabolism equal to 214 mg of alcohol/kg/hr, quite comparable to the figures for dogs which we have quoted. Thus it seems quite reasonable to assume that the rate of metabolism of alcohol in man and in the dog is essentially the same.

Further evidence regarding the rate at which alcohol can be metabolized in dogs may be secured from the following experiments. A 23-kg male dog was given a dose of 3.0 g of alcohol intravenously, and the blood alcohol concentration followed until it approached zero. The average rate of metabolism of alcohol so determined was found to be 156 mg/kg/hr. On another day the same dose was again given, followed by a constant intravenous infusion at a rate of 156 mg/kg/hr for a period of 3 hr. The blood alcohol concentration under these circumstances dropped from an initial figure of 363 mg/100 cc at the start of the constant infusion to 351 at the end. On two other occasions an initial dose of the same magnitude was given, followed by hourly doses administered by stomach tube at the same rate of 156 mg/kg/hr for a period of 8 hr. On one occasion the blood alcohol concentration dropped from 346 to 312 mg/100 cc, on the other from 330 to 312. Thus, in spite of the maintenance dose of 156 mg/kg/hr, calculated from the average rate of disappearance of alcohol after a single large dose, there was, on the average, a drop in blood alcohol concentration of 3.5 mg/100 cc/hr, which is equal to a rate of metabolism of 30 mg/kg/hr in excess of the maintenance dose. The experiment thus demonstrated that a maintenance dose of alcohol calculated from the average rate of metabolism after a single large dose was not sufficient to maintain the blood alcohol level constant at the highest level produced by such a dose. This constitutes additional proof of the fallacy of the hypothesis that the rate of alcohol metabolism is unrelated to dosage or blood alcohol concentration. The true rate of alcohol metabolism at this high blood alcohol concentration can thus be estimated as the sum of the maintenance dose of 156 mg/kg/hr plus the deficit of 30 mg/kg/hr, or 186 mg/kg/hr. If this rate be applied directly to man, the maximal daily consumption for a 70-kg man would be 312.5 g of alcohol, or about 26½ oz of 100 proof whisky, which falls in the same order of magnitude as the 32 oz calculated from prolonged daily consumption in dogs.

From these data we may then conclude that the maximum daily consumption of alcohol by a man of average weight is represented by a quart of 100 proof liquor, and that estimates greater than this are in error. Equally, it may be concluded that this consumption may only be achieved by maintaining the blood alcohol concentration at a high level.

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Preliminary Observations on the Biological Effects of Radiation on the Life Cycle of *Trichinella spiralis*

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Trichinella spiralis is the causative agent of human trichinosis. The disease is acquired as a result of eating undercooked meat, usually pork, containing the parasite in the encysted larval stage. Trichina infection appears to be somewhat common in the United States as it has been found in 14.34% of human post-mortem examinations (*2*). Since there is no simple economical method of treating meat at slaughter to kill trichinae larvae, any information which may improve present conditions is desirable. It has been found that a very intense beam of X-rays or cathode rays produced in a newly developed high voltage machine rapidly destroyed bacteria, yeasts, and molds, and the application of this method to the sterilization of food has been suggested (*1, 3*).

The writers, in this study, have undertaken some preliminary experiments to determine whether treatment of meat with radiations would have lethal action on the encysted trichinae larvae or would produce some morphological change which would prove detrimental to the life cycle of the parasite. For the purpose of clarity the life cycle of *Trichinella spiralis* is briefly summarized. The larvae develop and reach maturity in the intestinal tract of the host 2–3 days following ingestion of infected meat. On the fifth or sixth day about 99 to 100% of the female worms show embryos in the uterus (Fig. 1a). These embryos are liberated into the lymph spaces of the host's intestines and eventually reach the musculature where they become infective in less than 3 weeks.

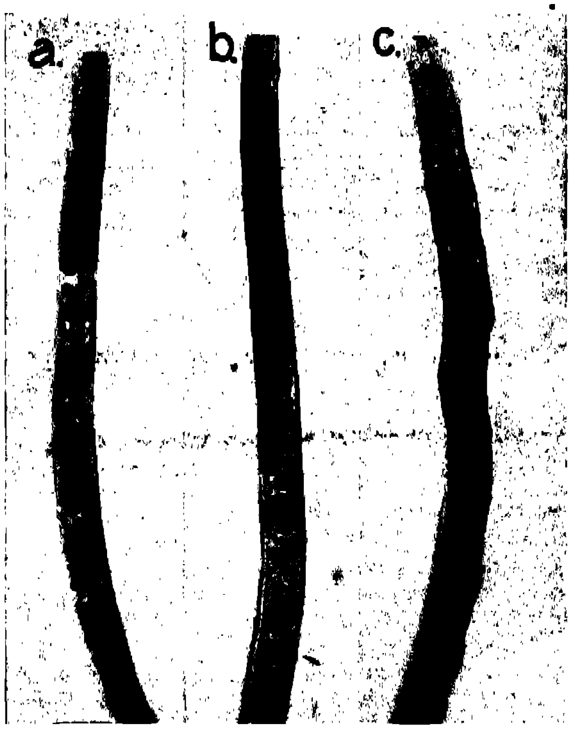

Fig. 1. Adult females of *Trichinella spiralis* recovered from small intestine of rats 6 days following experimental infection. (a) Normal adult with embryos in the uterus. recovered from a control rat which had received nonirradiated infected muscle; (b) adult showing undeveloped embryos in the uterus recovered from a rat which had received infected meat irradiated for 96 hr; (c) adult recovered from a rat which had received meat irradiated for 144 hr showing abnormality in the shape of the body wall.

The method used in these experiments consisted in preparing small cellophane wrappings each enclosing about 1 g of trichinous rat meat and placing the packets between two tubes containing radioactive cobalt, in a refrigerator at about 4° C. The dose of irradiation received by the meat was estimated to be 2000 r for each 24 hr, consisting largely of gamma rays, the beta rays having been filtered out. After the meat was irradiated for a specified interval of time, the contents of each of two wrappings were fed to each of two white rats.[1] One of the rats was killed 6 days after infection to determine the condition of the adult worms in the intestinal tract. The second rat was killed 30 days after infection to determine presence or absence of encysted trichinae larvae in the musculature; if larvae were not found by use of the press preparation method, the muscle was artificially digested and examined. A control rat receiving un-

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[1] Acknowledgment is made to Dr. A. R. Lamb, Experiment Station, H.S.P.A., for making laboratory animals available.

treated meat was maintained for each rat fed irradiated meat; both were killed at the same time.

In the present report, based on six separate experiments, the following observations have been made: Irradiation produced no lethal effect on the larvae nor did it affect their power of developing to the adult stage. Irradiation showed increased and variable deleterious effects on the reproductive cells of the adult female worms with increased dosage. In four experiments in which meat was continuously irradiated for 4 days it was estimated that 12 to 86% of the female worms were sterile, i.e., the embryos failed to complete their development (Fig. 1b). The remainder of the female worms showed embryos in the uterus. Irradiation for 5 days resulted in the sterility of about 43 to 100% of the adult females. Irradiation for 6 days resulted in the sterility of about 60 to 100% of the female worms. In two other experiments in which meat was irradiated for 4–6 days, presence of sterile female worms was observed but the percentage affected was not determined.

Female parasites, not made sterile as a result of irradiation, produced embryos which were able to invade the musculature of the host and become infective. Of six rats receiving meat irradiated for 6 days, and killed 30 days later, four showed no larvae in the musculature.

In addition to affecting the reproductive tissue, irradiation produced abnormality in the form of irregular elevations or vesiculations of the body wall of the parasite (Fig. 1c). This condition was evident along the posterior half of the female worm and was found to be more prevalent as the period of irradiation increased.

These results show that gamma radiation at the dose, intensity, and temperature applied is not lethal to trichinae larvae encysted in meat, but under proper dosage renders the female worms sterile and unable to complete their life cycle. Experiments are in progress to determine, among other things, the effects of larger dosages applied for a shorter time from a more intense source.

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Effect of Temperature on the Mutual Adhesiveness of Epithelial Cells[1]

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Previous work in our laboratory has demonstrated that an important physical characteristic of cancer cells is decreased mutual adhesiveness, and that this property is apparently due to a low calcium content of such cells (*1, 3, 4*). These observations have stimulated investigation of other factors which might affect normal cell adhesiveness and have led to the finding that adhesiveness is greatly affected by temperature.

The method used has been described previously (*1*), and only a summary will be given here. Attached pairs of human buccal epithelial cells were used. The force required to separate each pair by micromanipulation was measured. This force, calculated in milligrams, was determined by measuring the bend produced in a previously calibrated microneedle as it was moved in a direction tending to separate one member of a pair of cells from the other. During micromanipulation, the cells were kept immersed in a balanced salt solution. A constant high temperature was maintained by a warm box surrounding the micromanipulator; and a low temperature, by the use of a refrigerated room.

Adhesiveness of the epithelial cells was determined at three different temperatures. At room temperature of 22.5 ± 1° C the mean force required to separate 100 pairs of cells was 1.53 mg, with a standard error of ±0.067. When the epithelial cells were separated at 37 ± 1° C, their adhesiveness was found to have decreased; the mean value for 50 pairs of cells was now 0.88 mg, with a standard error of ±0.070. This value was significantly lower than that obtained at room temperature, for the difference in means was 6.7 times the standard error of their difference. Thus, it is concluded, an increase in temperature produced a decrease in adhesiveness of buccal epithelial cells.

When epithelial cells were separated at a low temperature (11 ± 1° C), the mean value of adhesiveness for 100 pairs of cells was 1.91 mg, with a standard error of ±0.100. This value was significantly higher than the room temperature value (1.53 mg), as the difference in means was 3.16 times the standard error of the difference. It is concluded, therefore, that a decrease in temperature produced an increase in adhesiveness of epithelial cells.

These results demonstrate that changes in temperature can significantly alter the adhesiveness of cells to each other. While quantitative measurements of most biological and biochemical processes change in the same direction as does the environmental temperature, the property of adhesiveness changes inversely as the temperature. Alterations in adhesiveness produced by changes in temperature may be of no great significance in homoiothermic animals, where body temperature remains approximately constant. However, such alterations are probably of importance in cold-blooded animals. Thus, Lucké and Schlumberger (*2*) have demonstrated that renal carcinoma of the leopard frog metastasizes more extensively when the environmental temperature is increased. Conceivably, increase in temperature may further reduce the already decreased adhesiveness of cancer cells, thereby leading to greater invasiveness and enhancing the chances for vascular dissemination.

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[1] Aided by a grant from the Donner Foundation.

Comments and Communications

The Electrochemical Restoration of Badly Corroded Silver-Copper Alloy Objects

The ancient Egyptians and the peoples that followed were well acquainted with the hardening effect of copper upon silver (sterling silver contains from 7.5% to 10% copper). Accordingly, it is not uncommon to come upon so-called "silver articles" during explorations and excavations of historical sites in Egypt or other countries bordering on the Mediterranean Sea.

The objects we investigated were found in graves or buried in the soils of Egypt, Greece, and elsewhere. The objects when found presented the appearance of badly corroded bronze objects with no indication that they were silver alloys. Accordingly, the objects were classified as copper-tin "bronze." They had the usual green-gray crust of corrosion products comprising the basic carbonates of copper, malachite, and azurite, together with a substructure of red cuprite. Intimately mixed with these copper compounds was a porous mass of clay or sand.

Accordingly, we treated the objects by our standard method for bronzes, making the objects cathode in a 2% solution of sodium hydroxide. It was not until the copper compounds had been reduced to metal that we met with the first indication that silver was present in this or that object. This silver was in the metallic state and located underneath the reduced copper. On the basis of the restoration results of a number of copper-silver objects we have enough evidence to indicate that the silver copper alloys were selectively corroded, copper going into solution in the acid or salt solutions found in soils. As long as any metallic copper was present this would protect the silver by causing it to become cathodic. Accordingly, we find the silver metal imbedded in a mass of copper compounds.

The corrosion of silver does not take place until all of the accessible neighboring copper has been oxidized. Corrosion proceeds radially from the original surface, and at a certain distance away from the original phantom surface the silver is precipitated, forming a structure that is frail but that reveals, somewhat magnified, the details of design of the original object. After the copper metal has been eliminated the silver is attacked by soil acids or soil salts in solution in the moisture in the soil: the reduction of the several silver compounds, notably the chloride and the black oxide, proceeds without much difficulty.

In a number of cases we have observed that the silver coin was larger in total volume than the original coin. The same observation applies to other silver objects. It would seem, therefore, that in the corrosion of a silver-copper coin there are a number of more or less distinct steps or stages:

1. The attack of the copper constituent by the corroding liquid in the soil.
2. The migration of the copper compounds, such as chlorides and sulfates into the porous or veined loamy soil. Eventually these copper compounds migrate until they reach the air and are then converted into basic salts such as malachite.
3. The dissolution of the copper constituent of the coin or other "hard silver" object continues through many years until only the silver remains.
4. During this process of copper dissolution, the silver constituent is electrochemically protected as long as metallic copper is present.
5. As soon as the copper is all corroded its protective action on silver stops, and the corroding agents attack the silver.
6. Silver salts migrate through the soil and pass copper salts until they encounter organic plant and animal matter. This matter has a strong reducing action on the silver salts and after considerable time has elapsed, a somewhat enlarged pure silver replica of the original "hard silver" object is formed.
7. These replicas are isolated during the process of restoration. The reduction of silver compounds to silver metal may not take place in the soil but it will take place during the electrolytic process of restoration.

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A Third Record of the Whale Shark, *Rhineodon Typus,* in the Caribbean Sea

In 1935, I published an article on the geographical distribution of the whale shark in which all known specimens were located. Because of its occurrence in the Gulf of Mexico, off Havana, Cuba, in the Florida Keys, and off the East Coast of Florida, I had long felt sure that Rhineodon must be found in the Caribbean Sea. In 1926 and in 1934, second- and third-hand reports came in that a great shark (thought to be Rhineodon) had been seen off Trinidad in the Gulf of Paria, and that another had been repeatedly observed off San Juan Harbor, Puerto Rico. Every effort was made to get definite data for each shark, but in the end these fish had to be put down as unverified possibilities of whale sharks.

First Record. Better fortune came later. On April 26, 1934, the *New York Herald-Tribune* recorded a great shark rammed and killed by the Grace liner *Santa Lucia,* on the run from Cristobal (Colon, Canal Zone) to Cartagena, Colombia. Correspondence with the Grace Line officials resulted in a visit to my office by Chief Officer A. E. Richards, who gave an exact description of the great fish. Here, then, was the first definite record of the occurrence of the whale shark in the Caribbean. This observation I published in 1937.

Second Record. Further definite evidence that Rhineodon occurs in the Caribbean came in 1937. The curious behavior of a great shark in the harbor of St. Marc, Haiti, around the steamer *Colombia* of the Colombian Steamship Company, was noted in a newspaper clipping sent me. A letter to the office of the company brought an answer from Pres. C. H. C. Pearsall, who at the time was on the steamer in the harbor of St. Marc. His description of this great fish positively identified it as Rhineodon, and this was verified by his inspection of a photograph in my office.

Mr. Pearsall carefully described the unusual behavior of this greatest of the sharks. It "hung around" the steamer while she was loading bananas under a strong electric light. A number of shots were fired at the unwelcome visitor, but they glanced harmlessly from his body armor of denticle-covered 4-inch skin. Once Rhineodon came up under the companionway, raised its head and dislodged the platform at the bottom of the ladder. The shark was about 25 feet long and when it bumped into the side of the ship, the impact was noticeable. An account of this fish and its behavior appeared in 1939.

Third Record. And now comes another authentic account of a whale shark in the Caribbean. Mr. Arlo Kalsheim, second officer of the tanker *Marathon* of Oslo, Norway, has kindly sent me a letter, via the U. S. Hydrographic Office, Washington, D. C., giving the following data. The *Marathon*, on a passage from Lisbon, Portugal, to Puerto La Cruz, Venezuela, had arrived on January 14, 1949, and anchored in that harbor in the afternoon. The officers were on the bridge awaiting orders from shore, when the captain called attention to a huge shark swimming near the vessel. Mr. Kalsheim writes that it was about 30 feet long and was swimming toward the ship. He had seen my article and figure published in the Hydrographic Bulletin in 1934 and at once recognized the visitor as a whale shark. He wrote that it was covered with spots over its whole body, as the published figure showed, and he estimated the width of the huge mouth at 4 feet. The great shark swam about the ship until dark, feeding on swarms of small fish and on other organisms at the surface. None of the ship's company had ever seen a shark of this size, shape, and color. It stayed on the shady side of the ship and hence it was impossible to take a photograph.

This behavior of the third Caribbean whale shark parallels that of the second specimen noted in these waters and of the two others which were reported by hearsay that could not be verified. This third Rhineodon had no fear of the ship or the crew, who, to a man, were hanging over the rail keenly interested. This behavior is typical of the whale shark. Secure in its armor of 4-inch-thick hide of tough fibers, the adult can be harmed by nothing that swims the seas. It has no enemies but man, and his harpoons and bullets will not penetrate its skin save when this is relaxed and shots are on the perpendicular—at an angle they glance off harmlessly. Man's surest way of killing this sluggish monster is by ramming it with a steamship—and a considerable number of such cases have been reported by the present writer (1940).

Those interested in the habits and behavior of *Rhineodon typus* will find all available material presented in my article, "The Whale Shark Unafraid," published in 1941.

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Some Current Misconceptions of N. L. Sadi Carnot's Memoir and Cycle

Recent authoritative texts state erroneously that Carnot (1824): (a) employed the discredited substantive or so-called caloric theory of heat, (b) discovered the second law without appreciating the first law, and (c) incorrectly pictured the descent of heat (*chute de calorique*) through an engine as analogous to the flow of water through a mill.

These misconceptions have arisen from improper interpretations of Carnot's terms *feu* (flame), *chaleur* (heat), and *calorique* (translated as "caloric" but should be interpreted today as entropy following Brønsted).

Clapeyron (1834) misunderstood Carnot and introduced unnecessary mistakes which Carnot had been careful to avoid. (CALLENDAR, H. L. "Heat" in *Encycl. Brit.*, 1911, *et seq.*). Clapeyron's mistake still dominates the literature a century later.

Kelvin (1849–51) interpreted the three terms indiscriminately as heat and unjustly criticized Carnot's proof. Clausius (1850) was acquainted with the memoir only through the work of Clapeyron and Kelvin. Ostwald (1892, *Klassiker* No. 37) remarked that Carnot used *chute de calorique* consistently when emphasizing the motive power of heat, but *chaleur* for general consideration, never *chute de chaleur*.

Brønsted (1937–47, *Phil. Mag.*, 1940, 7, 29: 699), has developed a new self-consistent and symmetrical system of energetics in which the reversible transport of any extensive quantity (entropy, mass, electric charge, etc.) through a corresponding conjugate difference in potential (temperature, gravitational or electric, etc.) is necessary for the production of work. (LA MER, FOSS and REISS, *Conference on molecular interaction*, New York Academy of Sciences, Am. N. Y. Acad. Sci., 1949, 51, Art. 4).

Carnot's cycle thus represents the conversion of thermal energy (TS) into mechanical work A by the fall of entropy through a potential difference $(T_2 - T_1)$

$$\delta A_{\text{thermal}} = \delta S(T_2 - T_1)$$

Brønsted's interpretation simplifies the presentation and renders unnecessary the accepted compensation theory of Clausius developed to harmonize Carnot's ideas (as Clausius understood them) with the first law.

This communication is based on a paper presented at the January 29 meeting of the American Physical Society. A fuller account documenting the assertions will be submitted to the *American Journal of Physics.*

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NEWS and Notes

Eduardo De Robertis, U. S. Public Health special fellow at the Department of Biology, Massachusetts Institute of Technology, has been appointed director of the Department of Cell Ultrastructure at the Institute of Biological Sciences, Montevideo, Uruguay.

Charles P. Huttrer, senior research chemist at the Warner Institute for Therapeutic Research, New York City, has been appointed research associate to the Subcommittee of Chemotherapy at the Chemical-Biological Coordination Center of the National Research Council.

Francis Birch, professor of geology at Harvard University, has been named Sturgis-Hooper Professor of Geology. He succeeds **Louis C. Graton**, who will retire this summer to become professor emeritus.

Ray C. Anderson, formerly a medical geneticist of the Army Medical Corps stationed in Hiroshima, has been named assistant director of the Dight Institute of Human Genetics at the University of Minnesota.

Charles L. Shrewsbury, of Midwest Research Institute, has been named chairman of agricultural chemistry at Southwest Research Institute of San Antonio and Houston, Texas, and associate director of the affiliated Foundation of Applied Research.

Visitors to U. S.

Hans Weddington, Fritz Wilhelm, and **Gerhard Bantzer**, German economists, are visiting a number of U. S. land grant colleges to study methods of distributing current economic information to German farmers.

Roberto Jaset, director of the Mineração Geral do Brasil, and of Usina Santa Olimpia Indústria do Ferro e Aço of South America, is studying different types of industrial equipment in this country. He plans to be here for three months.

B. L. Van der Waerden, of the University of Amsterdam, will be visiting professor for the summer quarter at the University of Washington, where he will give courses in algebraic geometry and operational methods in mathematical physics.

Grants and Awards

The Rockefeller Foundation has awarded to Duke University a grant of one hundred thousand dollars toward researches in physical biochemistry of proteins at the School of Medicine, under the direction of Hans Neurath. The grant is available for a seven-year period, beginning July 1, and has been made in addition to a similar grant of twenty-five thousand dollars awarded in 1946 for a five-year period.

Research Corporation has announced recent grants totaling nearly $250,000 to aid scientific research in colleges, universities, and institutes. One of the 65 grants—$54,550—went to George W. Kidder of Amherst College, for continuation of his work in cancer research, and another to Edward C. Kendall, of Mayo Clinic, for further study on the control of rheumatoid arthritis by an adrenal hormone.

The **John Wesley Hyatt gold medal** and $1,000 award were presented to George T. Felbeck, vice president, Carbide and Carbon Chemicals Corporation, New York City, at the annual meeting of the Society of the Plastics Industry. Dr. Felbeck received the award for engineering developments leading to the manufacture of polyethylene resins and plastics.

Mark Nickerson, assistant professor of pharmacology, University of Utah College of Medicine, was awarded the 1949 **John J. Abel Pharmacology Prize**—a bronze medal and $1,000—for his research on the pharmacology of the β-haloalkylamines, a new class of adrenergic blocking agents. The award, donated by the Eli Lilly Company of Indianapolis, will be made again in 1950. Inquiries may be addressed to the Secretary of the Society for Pharmacology and Experimental Therapeutics, H. B. Haag, Medical College of Virginia, Richmond 9, Virginia.

Sigma Delta Epsilon, the graduate women's scientific fraternity, is offering an award of $500 for research in the mathematical, physical, or biological sciences. The award, open to members only, will be made for an original research paper which has been published or accepted for publication this year by a scientific journal. Members of the research award committee are: Lela V. Barton, Boyce Thompson Institute for Plant Research, Inc., chairman; Elva Shipley Meyer, University of Wisconsin zoologist; and Helen Oldham, Department of Home Economics, University of Chicago. The award will be presented at the December meeting of the AAAS in New York City.

John Reenstierna, professor emeritus of Upsala University, Sweden, has been awarded the Finlay Order, Cuba's highest distinction, in recognition of his research leading to the development of a successful lepra serum.

This year's $2,000 **Charles L. Mayer "Nature of Light" Prize** has been awarded to Julian S. Schwinger, professor of physics at Harvard University. Dr. Schwinger won the award for his essays "On Quantum-Electrodynamics and the Magnetic Moment of the Electron."

Fellowships

The American Association of University Women has awarded 27 research fellowships of $1,500 each to women scholars for the coming academic year. Ten women scientists included among the recipients and their subjects of investigation are: Charlene Craft, instructor of anthropology at the University of Alaska, who will conduct an archaeological field trip into Upper Kuskokwim, the homeland of the Athabaskan Indians; Barbara D. Blanchard, assistant professor of zoology at Santa Barbara College, University of California, who will study the birds which migrate between California and

Alaska to learn the physiological effects of Arctic conditions on warm-blooded animals; Jacqueline Chittenden, lecturer in classical archaeology at the University of Edinburgh, who will do research on archaeological monuments relating to the cult of Hermes at the American School of Archaeology in Greece; Geneva Sayre, professor of biology at Russell Sage College, who will write a monograph on the varieties of rock-growing mosses of the *Grimmiaceae* family; Adela Cabezas, resident physician at Hospital Rosales, San Salvador, who will come to this country for postgraduate study in pediatrics; Alice B. Dickinson, fellow at the University of Michigan, who will do research in higher mathematics; Helen R. Garman, research assistant in plant physiology at the University of Wisconsin, who will study organ formation in plants; June Zimmerman, Physical Chemistry Laboratory, Oxford, who will complete a study of oxidation in bacterial systems; Lydia Bidinost, Buenos Aires biochemist, who will conduct advanced research in biochemistry at Columbia University; and V. Oldfelt, pediatrician, of Stockholm, Sweden, who will study virus diseases at Children's Hospital in Philadelphia.

Colleges and Universities

Construction of the $2,075,000 Nathan Goldblatt Memorial Hospital at the **University of Chicago** began officially with the laying of the cornerstone on May 17. To be completed in 1950, it will be the first unit in the university's $8,500,000 cancer research center. Adjacent to the Goldblatt unit, the Atomic Energy Commission will build the Argonne Cancer Research Hospital, for research on radioactive isotopes in cancer treatment.

The Massachusetts Institute of Technology has announced that Pomona College of California and Wesleyan University of Connecticut are the most recent additions to the cooperative liberal arts and technological study program which was established in 1936. The program offers qualified undergraduate students a specially planned three-year course in any of the 14 participating liberal arts colleges and enables them to complete in two years the requirements for a science, engineering, or city planning degree at M.I.T. Both a B.S. degree from M.I.T. and a B.A. degree from the liberal arts college are awarded on completion of the program. The other 12 participating colleges are: Amherst College, Amherst, Massachusetts; Bowdoin College, Brunswick, Maine; Miami University, Oxford, Ohio; Middlebury College, Middlebury, Vermont; Ohio Wesleyan University, Delaware, Ohio; Reed College, Portland, Oregon; Ripon College, Ripon, Wisconsin; St. Lawrence University, Canton, New York; Washington and Jefferson College, Washington, Pennsylvania; College of William and Mary, Williamsburg, Virginia; Williams College, Williamstown, Massachusetts; and College of Wooster, Wooster, Ohio.

The Department of Engineering Physics at Cornell University will offer a course in electron microscopy next fall, as a project of the new Electron Microscopy Laboratory, which will be established at the university as the result of a grant from the Rockefeller Foundation.

The Armour Research Foundation of Illinois Institute of Technology has begun research to stabilize calcium oxide (lime) for use as a refractory for rocket liners, jet airplane parts, and other industrial applications. The stabilization process, which will be directed by J. Scott Griffith, supervisor of ceramics, and John Neff, head of minerals research, is the second step in the project which the foundation is conducting for the Air Materiel Command. It must be preceded by the modification of high temperature electric furnaces so that they can be used up to 2300° C for sintering lime and other common oxides such as magnesium oxide.

Purdue University has established a permanent natural area of 70 acres, 12 miles from the campus, to preserve the biota for ecological study by the Department of Biological Sciences. This tract was bequeathed to the university by the late David E. Ross and is to be known as the Ross Biological Reserve. The land borders the Wabash River, and includes oak-hickory forest, bottomland forest along the river, two ravines with permanent streams, swampland, and old fields of several successional stages.

Industrial Laboratories

Mallinckrodt Chemical Works has elected as its new president Joseph Fistere, former vice president and director of the company. Mr. Fistere succeeds the late Arthur C. Boylston, who had been president since 1941.

Airborne Instruments Laboratory, Mineola, New York, has recently organized a research group known as the Applied Physics Section, headed by Rodney F. Simons. The new unit is developing a neutron velocity selector for Brookhaven National Laboratories, to be ready for use when the new atomic pile begins operation.

Meetings and Elections

An international conference on science abstracting will be held at Unesco House, Paris, June 20–25 for the purpose of developing and improving abstracting services for the natural sciences—both pure and applied—and considering methods of increasing their usefulness to scientists. Representatives from the member states of the United Nations and from its specialized agencies and other international organizations have been invited to take part in the conference. Others will be welcome as observers.

An international conference on electron microscopy will be held at Delft, July 4–7 under the auspices of the Section on Applied Physics of the Netherlands Physical Society. The meetings will include sections on Image Formation and Contrast, Resolving Power and Apparatus, and Specimen Techniques. American members of the Recommendation Committee are: Francis O. Schmidt, president, Electron Microscope Society of America; Charles J. Burton, secretary of the society; and Ralph W. G. Wijckoff, of the Department of Microbiology, National Institutes of Health, Bethesda, Maryland. Scientists interested in participating should write to Henri Polak, Technical Documentation and Information Center for the Netherlands, 525 Rolling Road, Chevy Chase 15, Maryland.

The American Association of Blood Banks will hold its second annual meeting in Seattle, Washington, November 3–5. The program is expected to interest both scientists and administrators of blood banks and hospitals. Further information may be obtained from the Office of the Secretary, 3301 Junius Street, Dallas 1, Texas.

The Kansas Academy of Science, at its 81st annual meeting at Kansas State College on April 28–30, elected the following officers: president, Paul G. Murphy; president-elect, A. B. Leonard; secretary, A. M. Guhl; treasurer, Standlee Dalton; and librarian, D. J. Ameel.

L. A. Maynard, professor of nutrition and biochemistry of Cornell University, and Rene J. Dubos, bacteriologist and member of the Rockefeller Institute for Medical Research, have been elected trustees of Science Service. Dr. Maynard was nominated by the National Academy of Sciences and Dr. Dubos by the National Research Council.

The following officers were renamed at the annual meeting: president, Harlow Shapley, director of Harvard College Observatory; vice president and chairman of the Executive Committee, Alexander Wetmore, secretary of Smithsonian Institution; treasurer, O. W. Riegel, director of Lee School of Journalism, Washington and Lee University; secretary, Watson Davis, director of Science Service. Additional members elected to the Executive Committee were: Frank R. Ford, editor, *Evansville Press*, Evansville, Indiana, and Karl Lark-Horovitz, Purdue University.

Deaths

Paul Bell Davis, 60, research chemist, died March 19 at his home in Baltimore. Dr. Davis, a member of the research and development branch of the Davison Chemical Company of Baltimore since 1919, was best known for his work in silicic acid gels during World War I.

Paul Harkai Schiller, 40, died in a skiing accident on Mt. Washington, New Hampshire, on May 1. Dr. Schiller, formerly head of the Psychology Departments at Pazmany University, Hungary, and Bolyai University, Rumania, had been research associate at the Yerkes Laboratories of Primate Biology in Orange Park, Florida, since 1947. At the time of his death he was temporarily engaged in research in the Department of Psychology at Harvard University.

Arthur Berkeley Yates, 48, chief geologist of the International Nickel Company, died May 10 in Montreal, where he had gone to receive the Barlow Memorial Medal of the Canadian Institute of Mining and Metallurgy at the institute's annual convention. He had been stationed in South Africa by International Nickel.

George T. W. Patrick, 92, professor emeritus of philosophy at Iowa State College, died of a heart attack at his home in Palo Alto on May 21. Professor Patrick's fields of investigation included the psychology of social reconstruction and the philosophy of the mind.

A Directory of Translators has been established by the Science-Technology Group of Special Libraries Association. It is located at the Southwestern Research Institute, San Antonio, Texas, and is operated as a free service to bring together clients having translation problems and language specialists in the fields of science and technology. Persons or firms needing qualified translators are invited to address inquiries to Wayne Kalenich, librarian, and translators are urged to place their qualifications on file with the directory. Twenty-three languages are already represented among the specialists listed and it is hoped that translators in all fields of knowledge will eventually be registered. Information concerning interpreters is also solicited.

The Special Libraries Association Translations Pool, also under the management of Mr. Kalenich, lists technical translations and information as to their loan or purchase. About three thousand translations have been indexed and persons planning to translate a technical article are urged to check with Mr. Kalenich to make sure that such a translation is not already available.

The National Registry of Rare Chemicals, 35 West 33rd Street, Chicago 16, has submitted the following list of wanted chemicals: 5,7,2′,3′-tetrahydroxyflavanone, 3,5,6,7,2′-pentahydroxyflavone, 3,5,6,7,3′,4′-hexahydroxyflavone, 3,6,2′,4′-tetrahydroxyflavone, 5,7,2′,4′-tetrahydroxyflavone, 4′-methyl-3,4-benzpyrene, 20-ethylcholanthrene, 3-chloro-20-methylcholanthrene, 6-cyano-20-methylcholanthrene, coriamyrtin, deuteroformaldehyde, 1-decalol, monodeuteroethylene, phenylpantothenone, cyclooctanone, picropodophyllin, muscarine, fructose-6-phosphate, thiomethylpentosides, cadinene, and keracyanin.

About one hundred numbers of the *Philippine Journal of Science* (1929 to 1941), are available to anyone willing to pay the cost of transportation. Not all volumes are complete, and articles on fishes and orchids have been extracted from a number of the issues. The publications may be obtained from Hugh Craig, Schnell Publishing Co., Inc., 59 John Street, New York City 7.

Institut International des Sciences Théoriques, of Brussels, has announced that a prize of 50,000 francs (Belgian) will be awarded for the best paper on the "Exposition and Critique of the Conceptions of Eddington Concerning the Philosophy of Physical Science." Papers must be submitted before December 31, 1950. Further information may be obtained from the Secretary, Institut International des Sciences Théoriques, 221, Avenue de Tervueren, Brussels, Belgium.

A new international journal, *Applied Scientific Research,* will be published at The Hague under the auspices of the Central National Council for Applied Scientific Research in the Netherlands, the Applied Physics Section of the Netherlands Physical Society, and the Section for Technical Scientific Research of the Royal Institute of Engineers of the Netherlands. The journal will be issued in two sections: A, containing papers on applied mechanics, hydro- and aeromechanics, heat, and the mechanical and thermal properties of materials; and B, containing papers on applied electrophysics, acoustics, optics, and the electrical, acoustical, and optical properties of materials. The subscription price is 20 guilders per volume for each section. American subscribers may send their orders and remittances through Tico and Lynch, Inc., Forwarding agents, 21 Pearl Street, New York City.

An *Interim Checklist of Holdings of 168 German Medical and Dental Periodicals, 1939–1948, in 38 Libraries of the United States and Canada* has been compiled by the **Committee on Periodicals and Serial Publications of the Medical Library Association.** The number of copies to be published will be based on the number of orders received by July 15. To assure receipt of a copy, an order, accompanied by remittance of $1.00, should be sent before that date to: Mrs. Edith Dernehl, Marquette University Medical Library, 561 N. 15th Street, Milwaukee 3, Wisconsin.

The Linnean Society of New South Wales announces that the position of Macleay Bacteriologist is open to qualified researchers in agricultural bacteriology. The appointment, which carries an annual salary of £600 to £900 (Australian) is for a five-year period. Further information may be obtained from the Secretary, Linnean Society of New South Wales, Science House, 157 Gloucester Street, Sydney, New South Wales, Autralia. Applications should include three references and must be submitted to the secretary by *June 30.*

The Atomic Energy Commission has announced that limited quantities of isotopically-labeled compounds, produced in excess of AEC needs, will be made available from the Oak Ridge National Laboratory upon allocation from the Isotopes Division. The only compounds now on hand are C^{14}-labeled sodium butyrate, sodium valerate, sodium caproate, and sodium heptanoate, but other labeled compounds will be added to the list. Elemental boron^{10} can also be furnished for research purposes. Inquiries should be addressed to the Isotopes Division, Atomic Energy Commission, Oak Ridge, Tennessee.

The AEC recently compiled a list of physicists, chemists, and biologists who have agreed to act as consultants on isotope techniques. This list (Isotopes Division Circular E-22) is available upon request from the Oak Ridge Laboratory.

The Growth of the Experimental Sciences, a pamphlet describing the experiment of President James B. Conant and his assistants in teaching the tactics and strategy of science to nonscience students at Harvard College, has just been published for private distribution through the courtesy of the Carnegie Corporation. Dr. Conant warns that his case-history approach is "both controversial and experimental." Copies will be mailed without charge, while the supply lasts, to any interested college professor or educational administrator on application to Guy Snavely, 726 Jackson Place, NW., Washington, D. C.

Recently Received—

Health Problems in Industry: A Digest of the Proceedings of the Joint Conference of Doctors and Businessmen, held at the Assembly Hall of the Commerce and Industry Association of New York, Inc., December 1, 1948. Available on request from the Information Service, New York University-Bellevue Medical Center, 141 Broadway, New York 6, N. Y.

Psychological Cinema Register: a nonprofit sale and rental distribution service of selected 16-mm instructional motion picture films in psychology, psychiatry, physiology and related fields, No. 6, 1949. Audio-Visual Aids Library, Pennsylvania State College, State College, Pennsylvania.

Occupational Outlook Handbook: Employment Information on Major Occupations for Use in Guidance, Bulletin 940, prepared in cooperation with Veterans Administration. Publication of the U. S. Department of Labor. For sale by the Supt. of Documents, U. S. Govt. Printing Office, Washington 25, D. C. at $1.75.

Hatchability of Chicken Eggs as Influenced by Environment and Heredity by Walter Landauer. Bulletin 262, April 1948, (revision of Bulletins 216 and 236). Storrs Agricultural Experiment Station, College of Agriculture, University of Connecticut, Storrs, Connecticut.

Journal of Calendar Reform, International Edition, First Quarter 1949. World Calendar Assn., Inc., 630 Fifth Avenue, New York 20, N. Y.

Expanding World Trade — U. S. Policy and Program. *Foreign Affairs Background Summary.* Issued by the Office of Public Affairs, Department of State, Washington, D. C.

Vegetation-Types Map of Tanganyika Territory by Clement Gillman. Available from the American Geographical Society of New York, Broadway at 156th Street, New York 32, N. Y. at $1.00 per copy postpaid.

Make Plans for—

American Society of Ichthyologists and Herpetologists, annual meeting, June 18–21, U. S. National Museum, Washington, D. C.

Inter-University High Altitude Laboratory, cosmic ray symposium, June 22–28, Echo Lake, Colorado.

Western Psychological Association, June 24–25, Eugene, Oregon.

American Physical Society, summer meeting, June 27–29, University of Washington, Seattle; meeting of the Division of Fluid Dynamics, June 30–July 1, Naval Ordnance Laboratory, White Oak, Maryland.

International Union for the Scientific Study of Population, August 27–September 3, Geneva, Switzerland.

The Committee on Inter-American Scientific Publication

Harlow Shapley, *Harvard University*

A DIRECT REPORTING SERVICE to all the 1,323 Peruvian physicians; the building up of a mathematical library in the City of Mexico; the processing and placing of 92 articles in technical and scientific journals of the United States; the compiling of a Latin American *Men of Science*—these are among the activities of a small committee that has been working for eight years in the interests of promoting both the international spirit of science and inter-American cooperation. Other activities include providing surveys of scientific developments in the United States, written by experts in the various fields, for publication in one or more of the many scientific journals of the other American republics; and working with half a dozen of the leading scientific societies of the United States in the preparation of monthly or bimonthly summaries of progress that are put at the disposal of Latin American editors.

The Committee on Inter-American Scientific Publication was started in September, 1941, under the auspices of the Coordinator of Inter-American Affairs. The plan was orginated by members of the faculty of the Massachusetts Institute of Technology and Manuel Sandoval Vallarta directed its activities for the first year. Since that time the committee has been under my chairmanship and its headquarters have been at the Harvard Observatory until very recently, when larger space became available at the American Academy of Arts and Sciences, 28 Newbury Street, Boston. From the beginning, Christina Buechner has been executive secretary.

The other committee members at the present time are: Roger Adams, chairman, Department of Chemistry, University of Illinois; Bart J. Bok, associate director, Harvard College Observatory, and chairman, National Research Council Committee on Unesco; Robert J. Caldwell, formerly minister to Bolivia, later dean of humanities, Massachusetts Institute of Technology and at present, cultural relations attaché, United States Embassy, Buenos Aires; Watson Davis, director, Science Service; James R. Killian, Jr., president, Massachusetts Institute of Technology; James H. Means, chief of medical services, Massachusetts General Hospital; and Franz Schrader, chairman, Department of Zoology, Columbia University.

A year ago the National Research Council and the American Association for the Advancement of Science agreed to provide joint sponsorship of the Inter-American Committee. They set up a joint advisory committee composed of: F. R. Moulton, formerly administrative secretary of the AAAS; E. C. Stakman, professor of plant pathology, University of Minnesota, and president of the AAAS; and R. L. Zwemer, executive secretary of the National Research Council.

If we judge by the wholehearted cooperation the committee receives from the scientists and scientific institutions of all the Latin American countries, we must grant that the project is meeting an important need in the promotion of One World of Science.

Our initial activity was directed to obtaining for the scientists of the other American republics a wider scientific audience for their technical contributions. Publication in Europe had been interrupted by the war and most North American scientists, unfamiliar with the Spanish and Portuguese languages, were unaware of the work of their southern colleagues. The Inter-American Committee asked Latin American scientists to submit technical papers that merited a wider attention than was provided by their national journals. An article sent to the committee, sometimes after screening by Latin American advisors, was translated, edited appropriately, and submitted, always on its own merits, to the editor of the most suitable journal in the United States.

This initial enterprise has been highly satisfactory. From its small budget the committee was able to pay for translation and a limited number of reprints, and to meet other minor expenses. Once good relations had been established between American scientific editors and Latin American contributions, our liaison work was completed. We had expected this particular function to decrease in importance, but we still receive many communications that need our intermediary assistance.

To date, 161 scientific articles have been sent to us from the south—from Argentina, Brazil, Chile, Colombia, Cuba, Ecuador, Guatemala, Mexico, Peru, Uruguay, and Venezuela. About 70 percent of the submitted manuscripts have been accepted by editors in the United States, for publication in the following journals: *American Heart Journal; American Journal of Hygiene; American Journal of Mathematics; American Journal of Pathology; American Journal of Physiology; American Journal of Roentgenology and Radium Therapy; American Journal of Tropical Medicine; American Mathematical Monthly; Archives* *of Pathology; Astronomical Journal; Astrophysical Journal; Biometrics Bulletin; Blood—Journal of Hematology; Cancer Research; Duke Mathematical Journal; Endocrinology; Gastroenterology; Genetics; Journal of the American Chemical Society; Journal of the American Pharmaceutical Association; Journal of Applied Physics; Journal of Bacteriology; Journal of Biological Chemistry; Journal of Chemical Education; Journal of Chemical Physics; Journal of Clinical Endocrinology; Journal of Mathematics and Physics; Journal of Nervous and Mental Diseases; Journal of Neurophysiology; Journal of Organic Chemistry; Journal of Pharmacology and Experimental Therapeutics; Physical Review; Physiological Reviews; Proceedings of the Society of Experimental Biology and Medicine; Science; Surgery, Gynecology, and Obstetrics;* and *Transactions of the American Mathematical Society.*

From the beginning we had hoped to make our work a two-way project. We felt that we should not only receive papers from Latin America, but that our scientists should contribute to publications in the various American republics. We have succeeded in carrying out this plan, again with surprising success. Three of the operations should be briefly described.

After considerable investigation, including a visit of the executive secretary to most of the universities and scientific institutions of Latin America, we discovered the rather unexpected fact that there are in existence more than 1,200 scientific publications in the Latin American countries. We found that the editors of many of the most important journals would like to use articles from North America, and especially to use those contributions that would help keep the scientists of the various countries in step with the rapid developments in the United States. One of the best ways to keep up with a subject is to get experts to write summaries of progress and problems in specific fields. We asked some leading American scientists if they would not send to us, for transmission to the most suitable Latin American journals, articles of 2,000 to 3,000 words. (Incidentally, we accompanied our request with the information that the small funds available would permit a payment of $50 to cover wear and tear on nerves and secretaries.)

Our solicitation of special surveys and summarizing articles has produced many original contributions. Of the 88 that have already been received, or are being prepared, I shall list only the first five papers received: "Human Biology of the Greeks," by J. Laurence Angel; "Modern Trends in the Tropical Meteorology of the Americans," by Robert D. Fletcher; "Some Recent Advances in Chemical Kinetics," by George W. Beadle; "Concerning Aging," by William deB. MacNider; and "Enzyme Kinetics and the Dynamics of Their Behavior," by Hudson Hoagland.

The submitted contributions are translated into the appropriate language by the journal editors. The articles have been so well received that some American editors have suggested that we put their journals on our list. One series of papers on architecture and home planning merits special mention. It was beautifully printed, with many illustrations by *Nuestra Arquitectura* in Argentina; the seven general American contributors were Charles Abrams, Henry S. Churchill, Jacob Crane, G. Holmes Perkins, José Luis Sert, Christopher Tunnard, and Catherine Bauer Wurster.

A second service from American scientists to Latin American colleagues is provided by the American scientific societies, which have arranged to send through the committee, for distribution to hundreds of scientific journals in Latin America, short and generally not too technical notes on current developments. We are greatly indebted to the societies, and especially to those who have compiled these periodical news items, for their liberal cooperation. The first summaries came from the American Chemical Society, the American Pharmaceutical Association, the American Medical Association, and the Geological Society of America. The editors receiving these various current science notes are permitted to use them with or without credit to the relevant society in the United States or to our committee. Naturally, the summaries are widely used.

I have already mentioned one of the special services—sending a monthly article, on some specific disease or medical subject, to the doctors in Peru. Three distinguished Peruvian physicians, Telemaco Battistini, Alberto Hurtado, and Carlos Alberto Seguin, have formed a committee to sponsor a special series prepared by American doctors and medical scientists. These articles are translated, published, and distributed to all practising physicians of the country. The first was by I. Forest Huddelson on the subject of human brucellosis (undulant fever) and the second by Chester S. Keefer on penicillin. Twenty of these up-to-date articles have already been published or are on their way. Needless to say, this assistance to the doctors and citizens of Peru is warmly appreciated. There are also direct and indirect benefits to the medical science of the United States. In tropical medicine, as well as in many other fields, we can learn much from our South American colleagues.

The work with the Peruvian medical scientists was greatly assisted through the personal interest of Ernest B. Howard, formerly associated with the Division of Health and Sanitation of the Institute of Inter-American Affairs and now assistant secretary of the American Medical Association. We find that our activities can often be coordinated with that of other organizations, to our mutual benefit. It is quite possible that the medical work for Peru can be extended to other Latin American countries. Progress is being made toward setting up other collaborative groups in Latin America which should promote not only interchange with our committee, but also useful interchanges among the scientists of the different Latin American countries.

There will probably be opportunities for important cooperation with Unesco's operations in the United States. Mrs. Buechner has worked with the Pan American Union in forming a guide and description of the various universities, colleges, and scientific institutions of the American Republics. The Inter-American Committee has also been closely associated with the large translation project managed by *Science Service,* and is thus in close contact with the scientific publishing houses of Latin America.

Finally, I should mention that the existence of the Inter-American Committee has become so well known in Latin American scientific circles that the office in Boston has the opportunity of undertaking a multitude of miscellaneous services. They include bibliographic work, guiding Latin American students and scholars in their travels through the United States, entertaining scientific visitors, and some assistance to the many science students in the Boston area (including the annual "Evening with the Stars" at the Harvard Observatory). To handle these miscellaneous operations competently, we shall soon require a larger budget and a larger staff.

The gratifying cooperation given our committee has led us to propose that the Committee on Inter-American Scientific Publication should become an International Committee on Scientific Information. From 34 countries of Europe and Asia we have received requests for the special articles by experts, for the summaries prepared by the scientific societies, and for other services of the sort we now give in the interests of our Latin American assignment. The cultural attachés connected with our embassies and legations in a number of countries in the Eastern Hemisphere have already distributed copies of our material. So far as it goes, this distribution from government offices in Europe and Asia is useful; but we feel that it would be better to deal directly with the scientists, and with their scientific journals and institutions.

Robert Ridgway's Color Standards

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PRIOR TO THE APPEARANCE of Ridgway's *Color standards and color nomenclature* in 1912 (*22*) English-speaking biologists had neither a standardized set of colors nor a generally recognized set of color names. Scientists had long been striving for accurate description but had not felt the specific need for precise color terminology until about 200 years ago, when the many naturalists interested in the mass of new material brought in by world explorers had to introduce order into their descriptions if the information they recorded was to be of any value to others. In two of the first important systematic works written in English, especial care was taken in respect to color records, both in the written descriptions and in the coloring of the copper plate engravings. Mark Catesby, writing in 1743 (*1*), says: "In Designing the Plants I did them fresh and just gathered; and the Animals, particularly the birds, I painted them alive (except a very few . . .)." He concludes by referring to possible color variability of two kinds: pigment changes in his illustrations and actual color differences in specimens arising from seasonal variations. George Edwards reported his methods of drawing, engraving, and coloring in the preface to *A natural history of birds* (*4*). He states: "A copy carefully and exactly coloured from the original drawings will be deposited in the Library of the College of Physicians, of London, which may serve as a Standard to refer to and to compare with, to try the Truth of the Colouring, in case the Plates should outlive me, and any should question the Authority of the Colouring." He adds, in Part II in 1747, "This book hath the Advantage to be Original in its Figures, as well as its Descriptions; not one of the former being copied from others, or the latter being translated or transcribed."

Many of the color records made since the development of modern systematics by Linnaeus, both in the early period and today, are very similar to those made by an early Canadian naturalist, Charles Fothergill (*7*), who in 1820 described the back of a sandpiper as "a light olivaceous yellow brown, or dead flesh color." Workers in color have been irritated by such terms, even though admitting that they are superior to imaginative descriptions such as "Elephant's breath" and "Isabella-colored," and have preferred to use descriptions such as olive, scarlet, and turquoise, or color words such as red, pink, and brown, modified in various ways as recommended by Judd and Kelly (*12*).

Color terms of any sort, however, cannot be used satisfactorily without reference standards, and standards cannot be used over any extended period of time unless they are reproducible. While standards of sorts have existed for many years, the three most widely used in the English-speaking world today are those that satisfy, in part at least, the color theories advanced within the last 100 years by Clerk Maxwell, Hermann von Helmholtz, and others. These three systems have much in common, but they differ considerably in some respects, and each possesses some unique attribute. The one devised by Albert H. Munsell (*16, 17*), a professor of normal school art, has qualities that give it fundamental importance when judged by modern physical and psychological standards. One introduced by Wilhelm Ostwald (*5, 20*), a great physical chemist, finds many applications in the field of decoration. The standards developed by Robert Ridgway are preferred by biologists. There are two apparent reasons for this preference: most of the colors needed by biologists are included, and most of the names assigned to the colors are satisfactorily descriptive according to everyday usage. Besides the frequent references to these standards in biological writings, there are also many uses in other fields which indicate their status. Dade (*3*) standardizes Saccardo's Latin Color Names (*24*) on a Ridgway basis; Maerz and Paul (*14*) make many references to Ridgway names and give their color equivalents; and Wilson (*26*), in his color charts for horticultural use, gives Ridgway names for his chips when possible, as does Villalobos (*25*) in a recently published set of standards.

Robert Ridgway (1850–1929) was curator of birds at the United States National Museum for over fifty years, and "was known and honored throughout the ornithological world," to quote an obituary (*27*). While he was an active student of bird life for some seventy years, and writing on the subject much of that time, as the dates of his 540 papers indicate (*9*), his contributions to the science of color are noteworthy also, because of his paintings and two books on color standards. Very early in his life he started painting portraits of birds, and they had become so good by the time he was ten years old that his schoolmates are said to have paid as much as fifteen cents each for them (*2*). Besides being interested in good illustrations, he became involved in the problems of color description in the taxonomy of birds and he saw the need for reference standards not only in ornithology, but also in the whole field of biology.

He attempted to satisfy this need by publishing in 1886 *A nomenclature of colors for naturalists* (*21*), illustrated with 200 hand-stenciled chips, and supplied with a glossary of parallel color name equivalents in seven languages. He justified the publishing of the book by writing: "The want of a nomenclature of colors adapted particularly to the use of naturalists has been more or less of an obstacle to the study of Nature," and he also elaborated on the fact that "popular and even technical natural history demands a nomenclature which shall fix a standard for the numerous hues, tints, and shades which are currently adopted, and form part of the language of descriptive natural history" (*21*).

This book was welcomed by contemporary naturalists and its standards are still occasionally used, but Ridgway himself apparently realized its limitations, for he continued to work on color standards and devoted all his spare time for twenty-five years (*9*) to their development and publication. He was encouraged and helped toward this objective by others, two in particular: professionally and financially by his great friend, Don José Zeladón, the famous Costa Rican ornithologist (*23*); and in the handling of details of publication and checking by his wife, Julia Evelyn Perkins Ridgway. *Color standards and color nomenclature*, with its 1,115 named colors, was finally published early in 1913 under the date of 1912, and is still the color system most generally used by biologists.

Ridgway set up his standards with the expectation that they would be exactly reproducible in the future, using methods and materials specified by P. G. Nutting of the National Bureau of Standards, but these are not adequate according to present conceptions of color accuracy. In 1912, standards and methods for the physical specification of visual colors were not yet available. Since then, exact methods have become available, have been accepted on the international level (*12*), and now are coming into general use. It is unfortunate that Ridgway chose some pigments which fluoresce (*8*) and are affected by humidity, by abrasion, by offsetting, and by hue shift (*10*). In addition, his arrangement of colors is such that it is impossible to specify exactly the colors falling between the 1,115 illustrated. This limitation is important, for it is currently accepted that over ten million shades of color are discernible to the normal observer (*12, 19*). Despite these serious handicaps, the Ridgway standards are still the favorite of biologists, and it is proposed to consider critically the advantages possessed by these standards and not by others.

Ridgway, like Munsell and Ostwald, developed his system of color description after extended study of color phenomena and ideas. It would appear that there were three stages in its development: first, a period of observation and record, in which he considered colors occurring in nature, pigments suitable for recording these colors, and names useful in describing them; second, organizing the colors within the color solid so that the final colors of his system were systematically spaced, with much use of the Maxwell color wheel; and third, reproducing the colors for publication.

The colors are disposed within a color solid on a series of concentric cones that are spread out on the chart as if they were cylinders. Around the mid-periphery of the outer cylinder are distributed the 36 highly saturated colors of his "pure spectrum scale." Above each color are the three "tints," obtained by systematic dilution with white, and below are the "shades" obtained by dilution with black. Thus there are seven colors for each hue in the series. The first cylinder of colors lying within the outermost is known as the "prime one" (′) series. The full colors on the mid-periphery of this cylinder are derived from the full colors of the outer spectrum series by dilution with a definite percentage of neutral gray, the tints by dilution with the same percentage of white as employed in diluting the first series, and the shades in a similar manner by dilution with black. Four additional series of colors, designated as prime two (″), three (‴), four (⁗), and five (′′′′′), are derived like the prime one series by addition of increasing amounts of neutral gray. For the central axis of his solid, Ridgway provided two series of grays, called Neutral Gray and Carbon Gray, to be used according to varying conditions.

As the system was planned, there should have been 1,512 colors (36 × 7 × 6), but Ridgway reduced the number of hues in the series of low saturation, (the reduction being from 36 to 7 in the prime five series, for example) so that the total is only 1,115, consisting of 1,057 regular colors, 42 extra colors, 14 grays, black, and white.

These 1,115 colors were primarily found by using the Maxwell color wheel, and were duplicated by painting. In making up the color chips for publication, enough sheets of paper were painted of each color to provide for an edition of 5,000 copies (*8*). The work was done by A. Hoen and Company of Baltimore, initially under the immediate direction of Ridgway and his wife. While troubles and accidents hampered them from the beginning (*9, 18*), the original painted sheets were sufficient for most of the required chips. Though further editions were contemplated, only one was issued. Some confusion on this point has been caused by a letter written in 1937 which has been interpreted as meaning that a second edition had been published (*13*). It had reference only to the completion of the edition.

It has already been noted that Ridgway was very early interested in satisfactory names for colors. From 1885 until 1912 he devoted considerable time to choosing suitable names for his colors from those currently used, and to modifying color names in simple ways to describe related colors. While "Isabella-colored" and "Invisible Green" occur in his nomenclature, there are remarkably few names not suggestively descriptive. In general, the Ridgway names are so good that they have been adopted widely, and it is likely that these names will be applied for a long time to colors similar in appearance to those that he named. He provided, in addition to the names, a system of notation. This is not very generally used, but it is the only method for identifying the 4,559 in-between colors, recognized in the system but not provided with names or chips.

Biologists are sometimes asked by color workers why they prefer the Ridgway standards. This question has been answered by a mycologist: "I can find the colors I want there, other mycologists use the same standards, and the literature for years has employed Ridgway names." Mass use by biologists is indicated by similar statements from other specialists, and also by the replies to the Canadian Questionnaire (*15*). It would thus seem probable that Ridgway standards would continue to be used for many years to come if they were permanent, and if new copies could be obtained, regardless of the scientific advantages of other methods of color description.

Answers to the Canadian Questionnaire and many personal discussions have clearly indicated that other color systems have been considered and used. Many biologists have tried and have flatly rejected the *Munsell book of color* as unsuitable for biological work. In developing his key to Ridgway in terms of Munsell notations (*8*) the author became interested in this point of view, which seems to be caused primarily by the lack of matchable colors. After work on the key was finished the notations of the Ridgway colors were examined to see if there was a foundation for this opinion. It was found that of the 1,057 regular Ridgway colors, 454 are outside the range of the 40-hue *Munsell book of color*: 221 are higher in value and/or chroma; 136 found in 18 hues possess a lower chroma;

and 97 are marginal. The number of low chroma colors is noteworthy, for they are especially useful in ornithology, mammalogy, and mycology. The need for low chroma Munsell colors has now been recognized by publication of special colors for soil work.

The future of the Ridgway standards and the Ridgway appraisal of color needs. In summarizing the present status of the Ridgway standards and their place in future color description there are two main considerations. The first is that there is no means of reproducing the original colors exactly and it is possible to give only approximate equivalents, as has been done in other systems and in the author's key now being published. The second is that experience has shown biologists generally are satisfied by the selection of colors that Ridgway worked so long and successfully to fit to their needs.

In view of these facts biologists might well consider the adoption of a comparably inclusive but permanent system of color description. While such a system might be entirely new, it could be much more readily developed, and would make available a very large body of information and past experience, if it were standardized primarily on the international basis provided by I.C.I. agreements of 1931 (*11*). It could be fitted into the Munsell color solid, so that there would be no need for an entirely new set of standards, but only a series of specialized sets of color corresponding to those parts of the Ridgway colors that have been most widely used in the various special fields. If this were done at an early date, aid could be obtained from active users of Ridgway and it would not be necessary to depend upon records in the literature and a key, both of which have distinct limitations, chiefly because of actual physical changes in the various copies of Ridgway standards.

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TECHNICAL PAPERS

The Genetic Effects of Low Intensity Irradiation[1]

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It has been shown by Spencer and Stern (*3*) that irradiation by X-rays at high intensity induces mutations in sperm of *Drosophila melanogaster* at dosages as low as 50 r and 25 r, and that the proportionality between r dose and mutation frequency is maintained down to these low dosages. Earlier workers had established independence of induced mutation frequency from the intensity of irradiation at high and medium dosages. In contrast to these findings, Caspari and Stern (*1*) obtained no significant difference in mutation rates between controls and experimentals, which had been subjected to a dose of 52.5 r in gamma rays administered continuously for 21 days at a rate of 2.5 r per day.

This unexpected result required further tests. After consideration of various factors the following were regarded as possible causes for the apparent inactivity of irradiation in the experiment by Caspari and Stern: (1) low sensitivity to irradiation of aged sperm, (2) dependence of induced mutation frequency at low dosages on a time factor, and (3) errors of sampling which might have obscured a true difference between control and experimental rates. The first possibility was studied by administering 50 r in gamma rays continuously over 24 hr to sperm which had been aged previously for 20 days in the spermathecae of females (*4*). In this experiment the intensity of irradiation was raised several times over that used by Raychaudhuri (*2*) who had found typical intensity independence of mutation rates. Any deviation from the effect of irradiation expected for 50 r at medium intensity would thus be due to a specific sensitivity or insensitivity of the aged sperm. The second possibility, interference by a time factor, was tested by increasing the intensity of irradiation, and the total dosage, by a factor of 2, that is, by administering 100 r instead of about 50 r through continuous gamma irradiation over 21 days. The third possibility, chance, was checked by a repetition of the original experiment, that is, by giving once more 52.5 r in gamma rays over 21 days. Parallel with each experiment, the spontaneous mutation rate was determined in a set of controls.

TABLE 1

MUTATION RATES FOR SEX-LINKED LETHALS IN SPERM OF *Drosophila melanogaster*, AFTER DIFFERENT TYPES OF TREATMENT

Treatment	No. of controls	No. of experimentals	Mutation rate percent			Significance of difference	
			Controls	Experimentals	Difference	χ^2	P
50 r, 2.3-5 min exposure, not aged (Spencer and Stern)	73,001	31,560	0.0974	0.2440	0.1466	33.07	<< 0.01
52.5 r,* 21 days' exposure, aged (Caspari and Stern†)	56,252	51,963	0.2489	0.2848	0.0359	1.31	0.26
50 r,* 24 hr exposure after 20 days' aging	44,601	46,232	0.1682	0.2834	0.1152	13.81	<<0.01
100 r, 21 days' exposure, aged	22,958	31,562	0.2352	0.4658	0.2306	10.23	<<0.01
52.5 r,* 21 days' exposure, aged	36,184	29,424	0.1765	0.2542	0.0777	4.67	0.03

* Geometric errors in the administration of the radiation are larger than the difference between the values of 52.5 and 50 r.

† The mutation rates obtained by Caspari and Stern have been adjusted to the slightly different scoring of lethals used in the investigations reported in this paper.

The data, together with the earlier findings by Spencer and Stern (*3*) and Caspari and Stern (*1*), are summarized in Table 1. It is seen that all three new tests gave an increased frequency of sex-linked mutations in the treated sperm as opposed to the controls. The experimental rate observed by Caspari and Stern is statistically in good agreement with later determinations. The control rate of 0.2489% found by Caspari and Stern is higher than any one of the later control rates. By itself a rate of 0.2489% for sperm aged over 21 days as compared to 0.0974% for sperm not aged (Table 1, line 1) seemed in line with the degree of increase expected, according to the experience of other workers, after such aging. The new data on the control mutation rate in aged sperm suggest considerable variation of age accumulation of mutations in the Canton Special stock on which all tests were carried out.

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[1] The work described in this report was performed under the auspices of the Atomic Energy Commission.

A comparison of the differences in mutation frequencies between experimentals and controls in the chronic experiments (lines 2–5) with the difference in the acute experiment (line 1) should take into account the fact that the difference in the latter experiment is somewhat larger than expected on the basis of all of Spencer and Stern's data. The maximum likelihood calculation yields about 0.002% induced sex-linked mutations per r, which corresponds to an expected difference for the acute 50-r experiment of only 0.1000%. Viewing all experiments together, it appears that irradiation at low dosages, administered at low intensity, induces mutations in *Drosophila* sperm. There is no threshhold below which radiation fails to induce mutations. A more detailed account of the work will be presented later.

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An Electrical Logic Machine

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At the first annual open house meeting at Lewis Institute in 1936, the writer demonstrated an electrical Logic Machine useful for detection and demonstration of fallacies in deductive reasoning. The machine is equipped to test all syllogisms (categorical, hypothetical, and disjunctive), and both conversion and obversion. To facilitate portability, the machine is mounted inside the top half of a sturdy suitcase, with the classified blocks (representing propositions) resting in thin plywood compartments in the bottom half of the case. Total weight of the case, including machine and blocks, is 25 lb.

In order to test a syllogism, it is only necessary to select the blocks representing the major premise, minor premise, and conclusion, and place the blocks onto the three spaces provided on the panel of the machine. If the syllogism contains one or more fallacies, one or more light bulbs will light up. Each light bulb is identified by a printed name of a fallacy, as follows:

1. Undistributed middle.
2. Illicit major.
3. Illicit minor.
4. Two negative premises.
5. Two particular premises.
6. Affirmative conclusion from negative premise.
7. Universal conclusion from particular premise.

For the hypothetical syllogism, there are light bulbs for "Denying the antecedent," "Affirming the consequent," and "Hypothetical *non sequitur.*" For the disjunctive syllogism, there is a light bulb for "Disjunctive *non sequitur.*" There is one bulb for "False conversion," one for "False obversion," and a colored light bulb indicating that electrical current (battery or line) is established.

The principle of operation is that of establishing metal contact areas on the backs of flat wooden blocks, to convey information concerning the proposition printed on the front of the block. For example, the block representing the proposition "Some M is not S" (minor premise) has separate contact areas at selected positions on the back of the block, to represent the following items of information:

1. The middle term (M) is undistributed (that is, it refers to a limited number of its class).
2. The proposition is negative.
3. The proposition is particular (refers to "some").

Since, by definition, the conclusion of a syllogism represents the minor term by the letter S (subject), and the major term by the letter P (predicate), there are four blocks representing possible conclusions: All S is P, No S is P, Some S is P, Some S is not P. Using M for the middle term, there are eight blocks for all the possible combinations with P in the major premise, and eight blocks for the possible combinations with S in the minor premise. Additional blocks provide for testing hypothetical syllogisms, disjunctive syllogisms, conversion, and obversion.

Pairs of banana plugs in the panel receive items of information from the contact areas when the blocks are set onto the panel. Certain combinations of propositions will close one or more electrical circuits wired from the panel to pilot light bulbs. There is a separate circuit for each possible fallacy.

The panel is black hard rubber, 7 in. × 10½ in. × 3/16 in. To insure correspondence, a template was used to drill identically separated holes on both the panel and the wooden blocks, separated 5/16 in. horizontally, ¼ in. vertically. The banana plugs were inserted in the panel holes and secured with nuts behind the panel. The wiring is soldered to the back end of the plugs (behind the panel) and it leads to the pilot light sockets mounted on a vertical strip of black hard rubber. A white card next to the bulbs has a printed title for each kind of fallacy, indicated by the appropriate bulb. A knife switch permits use of either battery or line current; a transformer for line current is attached and wired behind the panel, out of sight. Panel, light sockets, and knife switch are mounted on a pressed cardboard backing, 17 in. × 14½ in. × ⅛ in. The backing is mounted inside the top of a suitcase.

The blocks are of hard wood, 5½ in. × 2½ in. × ¾ in. The contact areas consist of a pair of adjacent jacks soldered at their point of adjacency. The holes were drilled in the wood through the same template used for the panel, and were then widened to 3/16 in.; depth was ½ in. Then the blocks were sandpapered until they were smooth and easy to handle. The jacks were made from brass tubing, ¼ in. OD, 5/32 in. ID, cut into ⅜ in. lengths. One end of the jacks was trimmed down, to facilitate entry into the blocks. After each pair of jacks was hammered in, flush with surface, a narrow hole was drilled between the two jacks, solder was inserted, and the jacks were countersunk after the solder hardened. Now the blocks could be set onto the banana plugs on the panel and would close certain parts of the circuits involved.

Earlier machines by Stanhope (*8*, *1*), Jevons (*3*, *4*), Venn (*9*), Marquand (*6*), Pastore (*7*), and Macaulay (*5*) generally indicated the conclusions derivable from given premises. None could identify the fallacy in deductive thinking. However, in an article written in 1935 on the mechanical nature of problem solving, Hull (*2*) mentioned that he once constructed a "simple mechanism of sliding disk-segments of sheet-metal which will solve automatically, i.e., exhibit the conclusions logically flowing from all of the known syllogisms and which will automatically detect all of the formal fallacies . . ." but that ". . . a description has not yet been published."

The logic machine described by the present writer is an electrical device which identifies the formal fallacy (or fallacies) in an invalid syllogism of the categorical, hypothetical, or disjunctive types, or in conversion and obversion. It has been used successfully in logic classes and evokes sharp student interest. As with all such machines, its obvious limitation is that the "argument" must first be put into logical form by a human being.

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The Application of Soybean Inhibitor in Tissue Cultivation

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It is well known that certain types of tissue cells liquefy clots of homologous plasma, thus making their permanent cultivation impossible. Carrel and Ebeling (*1*) attempted unsuccessfully to prevent such liquefaction by adding traces of unsaturated fatty acids, egg yolk and other substances to the medium. The present author (*2*) cultivated permanent strains of the Rous sarcoma cells *in vitro* for many years by putting a small piece of boiled muscle tissue beside the tumor tissue. The dead muscle tissue served as a kind of solid substrate which was invaded by the sarcoma cells and thus it made possible the transfer of the cells from medium to medium. This method of course did not allow quantitative estimations of the rate of growth characteristic for the tumor cells. Later we found that sarcoma cells grow readily on certain heterologous media without liquefaction of the medium, probably because the chicken cells are unable to activate the proteolytic enzymes in the heterologous plasma (*3*).

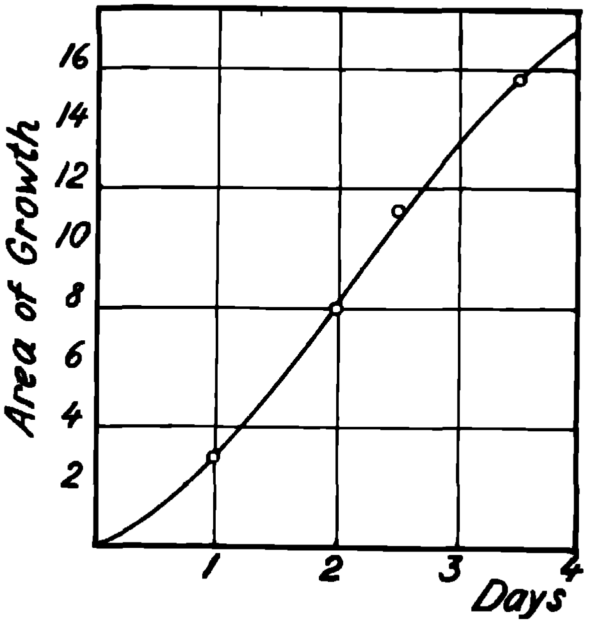

FIG. 1.

In this paper a method will be described for the cultivation of Rous sarcoma cells on clots of homologous plasma in which it was found that liquefaction could be prevented by an addition of the soybean inhibitor first isolated by Kunitz (*4*). In this manner it was possible to measure the rate of growth of the Rous chicken tumor cells in homologous plasma medium. The growth-retarding effect of soybean inhibitor on the growth of myoblasts will likewise be described and discussed.

The plasma medium in Carrel flasks was made up as follows: *Solid phase*—0.5 ml chick plasma, 1.0 ml Tyrode's solution, and 0.2 ml of a 0.35% solution of trypsin inhibitor; this was coagulated by adding 1 drop of embryo juice. *Fluid phase*—0.4 ml mixture of equal volumes of chick serum and Tyrode's solution, and 0.2 ml embryo extract.

Liquefaction of the medium was found to be completely prevented. Fig. 1 demonstrates the regular growth of the Rous sarcoma cells when cultivated in the presence of the inhibitor. The growth rate of the cells under the conditions of this experiment could now be accurately measured and was found to be relatively low. It therefore seems that the soybean inhibitor slows down the growth rate of the tumor cells.

Further it was found that the inhibitor prolongs the coagulation time of the plasma used. In those of our experiments in which the inhibitor was added to the blood plasma and not to be supernatant fluid of the flask cultures the coagulation of the plasma was found to be considerably delayed or completely prevented, even when large amounts of embryo juice was added. These facts suggest that the inhibitor acts on the system involved in the coagulation of the blood plasma as well as on the proteolytic enzymes of the surface of the cells, the desmo-enzymes.

Recently Overman and Wright (*5*) have observed that the trypsin inhibitor decreases the thromboplastic activity of the blood. The study of the effect of the soybean inhibitor on the growth of the cells must therefore be limited to such concentrations of inhibitor as will still allow coagulation of the plasma medium to take place. When the inhibitor, instead of being added to the plasma directly, is introduced into the supernatant fluid of the culture medium, the growth-inhibiting effect is relatively less pronounced.

The figures below illustrate the relative growth inhibition of fibroblasts as a function of increasing amounts of a rather dilute solution of the inhibitor which has been *introduced into the plasma medium* before clotting:

0.17% inhibitor solution	$Q = \frac{\text{Control}}{\text{experiment}}$[1]
0.1 ml	1.01
0.2 "	1.43
0.3 "	2.24
0.35% inhibitor	
0.2 ml	2.22

Thus when more than 0.3 ml of a 0.17% solution of the inhibitor is added to the plasma clot, no further suppression of the growth takes place. This seems to indicate that the proteolytic enzymes are completely inhibited by that concentration.

The following results show the effect of a 0.7% inhibitor *added to the fluid phase of the culture medium*:

0.7% inhibitor solution	$Q = \frac{\text{Control}}{\text{experiment}}$
0.25 ml	1.44
0.30 "	1.20
0.35 "	1.18

To establish a certain degree of growth inhibition of tissue cells in a Carrel flask the concentration of inhibitor has to be four times that necessary to obtain the same degree of inhibition when the inhibitor is introduced in the solid phase of the plasma clot.

Two main facts have been observed in this investigation. The soybean inhibitor has been shown to be an important tool in the tissue cultivation technique. An addition of small amounts of inhibitor to the plasma medium stabilizes the clot and makes it possible to cultivate on homologous media tissues with strong inherent proteolytic activity. Thus it is now possible to cultivate malignant cells indefinitely and to make quantitative estimations of the rate of their growth. It will also be possible now, we believe, to study differentiation phenomena *in vitro* by means of suppressing the growth of the cells and slowing down their migration rate.

We are grateful to Professor Kunitz for supplying the crystalline trypsin inhibitor, and to the International Cancer Foundation, which provided financial support.

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[1] The tissue area increase is measured by means of a planimeter and expressed in square centimeters, the area being projected with the aid of an Edinger projector enlarging 20 times. Q is a measure for the inhibiting effect.

Occurrence of Vitamin B_c Conjugase in Human Plasma

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The occurrence in yeast extract of an antianemic principle, different from pteroylglutamic acid, but releasing that substance after acid or enzymatic hydrolysis, was first demonstrated by Binkley, *et al.* (*1*). Pfiffner (*2*) isolated this compound and named it temporarily vitamin B_c conjugate.

In 1947 Schweigert and Pearson (*3*) studied the folic acid content of blood plasma and corpuscles in Mammalia and fowl, before and after treatment with an enzyme, takadiastase, releasing folic acid from its microbiologically inactive forms. They could find only minute amounts of free folic acid, but it seemed from their experiments that vitamin B_c conjugate was present in significant amounts.

TABLE 1

Folic Acid Released after 2-hr Incubation at 37° C of a Mixture of Human Plasma and Takadiastase*

Plasma ml	Takadiastase mg	B_c released mμg
0.5	20	25
0.5	20 (boiled)	25
0.5 (boiled)	20	2
none	20	1.6
0.5	none	0

* Microbiological determination with *Str. faecalis*.

A careful study of the interaction between takadiastase and plasma, both in the native state and after boiling for 10 min, has led to opposite results (*4*). The plasma is deprived of B_c conjugate, but it contains a thermolabile enzyme, which releases folic acid from a conjugate. The role of takadiastase in this interaction is that of a substrate containing vitamin B_c conjugate in significant amounts. Folic acid is set free, see Table 1, after incubation with plasma for 2 hr at 37° C,[1] the pH of the digestion mixture being 4.5.

Striking results were obtained with a crude extract of baker's yeast (containing 3.7 µg B_c per cc in conjugated form) from which 0.2 cc plasma liberated 0.7 µg folic acid in 1 hr at 37° C.

Additional evidence of the enzymatic role of plasma is offered by the use, as substrate, of pure crystalline vitamin B_c conjugate,[2] which gives identical results.

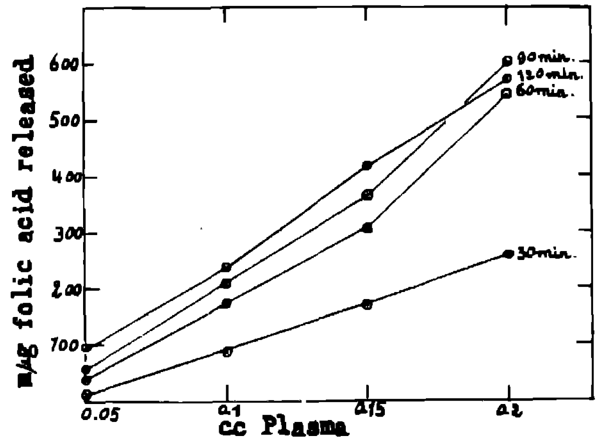

FIG. 1. Liberation of folic acid after various incubation periods at 37° C of 0.5 cc yeast extract + human plasma + 5 cc sodium acetate m/10 at pH 4.5 + water (total volume = 10 cc).

The B_c release as a function of plasma concentration for a constant time of incubation is represented in Fig. 1. There appears to be a linear relationship for plasma concentrations, ranging from 0.05 cc to 0.15 cc.

The study of human plasma conjugase activity in normal and pathological conditions has given the following results: under standard conditions, viz., with incubation at 37° C and pH 4.5, a mixture of 0.15 cc heparinized plasma and 0.5 cc yeast extract made up to a volume of 10 cc, liberated 0.5 µg to 1.5 µg folic acid per cc plasma in 90 min, with a maximum frequency of 0.8 µg to 1.0 µg. No significant variation of conjugase activity could be detected in pernicious anemia or in other pathological conditions, with the exception of asystolic patients, where the amount of conjugase per cc plasma was sometimes considerably decreased and attained values of 0.2 µg to 0.7 µg folic acid.

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[1] In a recent communication published while this article was in press, Simpson and Schweigert came to similar conclusions. (*Arch of Biochem.*, 1949, **20**, 32.)

[2] Crystalline vitamin B_c conjugate used in this experiment was supplied by Parke, Davis & Co. Laboratories, Detroit.

The Effects of Choline and Methionine on Phospholipide Formation in Patients with Liver Disease as Measured by Radioactive Phosphorus[1]

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In the past ten years the importance of nutritional factors in the pathogenesis and prophylaxis of experimentally induced cirrhosis in animals has resulted in a modification of the therapeutic regime in human patients. Of special interest has been the use of a diet high in protein and the administration of vitamin supplements, liver extracts, and lipotropic factors, such as methionine and choline. The efficacy of the above regimen is reflected in the lower mortality figures now being reported in the treatment of advanced instances of cirrhosis (*3*). In general this improvement is ascribed in part to a regenerative action on the liver tissue and in part to the lipotropic action of methionine and choline, resulting in the removal of the fat accumulated in the liver. The latter effect has been interpreted as being due to an increased formation of phospholipides.

In experimental animals with dietary fatty liver it has been shown, by the use of radioactive phosphorus as an indicator, that the administration of choline (*2*) or methionine (*8*) causes an increase in the rate of the synthesis of phospholipides in the liver. Since the plasma phospholipides are synthesized almost entirely in the liver (*5*), it seems that changes in the rate of formation of liver phospholipides would be reflected by corresponding changes in the amounts of newly formed phospholipides in the plasma. Indeed, in dogs on a diet low in protein and high in fat (*7*) a stimulatory effect by choline on the turnover of phospholipides in plasma has been observed.

We now have in progress a systematic study of the turnover of plasma phospholipides in normal human beings and in patients with various diseases. Some preliminary findings have been reported in a summarized form (*4*) and more extensive data will be published elsewhere. We are here reporting only some results obtained in two cirrhotic patients who exhibited a marked response to a single large dose of methionine or choline. These results suggest certain possibilities which might be of considerable interest in the interpretation and treatment of this disease.

One 31-year-old white male (O.A.) and one 36-year-old

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[1] Supported in part by a grant from the U. S. Public Health Service. The P^{32} used in these experiments was obtained from the National Laboratories, Oak Ridge, Tennessee on allocation from the U. S. Atomic Energy Commission.

[2] We wish to acknowledge the helpful suggestions and constructive criticism of Dr. Camillo Artom and the technical assistance of Dr. Benjamin Vatz and Mr. Jesse C. Trott, Jr.

white female (N.M.H.) having clinical evidence of advanced portal cirrhosis were studied. At the time of admission, both were jaundiced and had demonstrable ascites, edema, and hepatic enlargement. Both gave a history of marked alcoholism. Definite impairment of liver function was found, as demonstrated by determinations of total serum proteins, albumin and globulin, vitamin A levels and by various tests, such as bromsulphalein, galactose tolerance, and hippuric acid excretion. In both instances, needle aspiration biopsy of the liver showed cirrhosis and fatty infiltration.

TABLE 1

EFFECT OF LIPOTROPIC AGENTS ON SPECIFIC ACTIVITY OF PLASMA PHOSPHOLIPIDES

			Plasma phospholipides		
Patient	Treatment	Time in hr	Radioactivity per 100 cc* r.r.u.	Mg phosphorus per 100 cc†	Specific activity‡ × 100
O.A.	Injection of P^{32} + 9g choline orally	0	....	11.70	...
		24	1.785	11.16	16.0
		48	1.740	10.25	17.0
	P^{32}	0	....	7.96	...
		24	0.450	6.90	6.4
		48	0.766	6.23	12.3
		84	1.356	8.92	15.1
	P^{32} + 9g choline orally	0	....	11.25	...
		24	0.710	11.72	6.1
		48	1.012	11.30	8.9
N.M.H.	P^{32} + 6g methionine I.V.	0	....	11.64	...
		24	3.810	11.10	34.3
	P^{32}	0	....	9.01	...
		24	0.531	6.41	8.3
		48	1.270	7.60	10.7
		72	1.770	9.40	18.8
	P^{32} + 10g methionine I.V.	0	....	5.11	...
		24	0.712	6.70	10.6
		48	1.334	8.28	16.1
		72	1.700	9.68	17.5

* Expressed in relative radioactivity units (r.r.u.), the total dose injected being equal to 10^4 r.r.u.

† From the lipide P the total plasma phospholipide can be calculated (mg of P × 22.7).

‡ The specific activity is the ratio of the radioactivity (in r.r.u.) to the phosphorus (in mg) in the lipide extracts.

The patients were given an intramuscular injection of radiophosphorus in the form of Na_2HPO_4 (0.5 mc). Blood samples were taken routinely at 0, 24, 48, and 72 (or 96) hr. The plasma was separated and the lipids extracted with hot alcohol, alcohol-ether, and chloroform. On aliquots of the chloroform solution, the radioactivity (*1, 2*) and the phosphorus (*6*) were determined. At the time of the first injection of the radiophosphorus, the patients were given a single large dose of methionine (6 g intravenously to patient N.M.H.), and choline chloride (9 g orally to patient O.A.). After several months of treatment with methionine (1 g three times per day), the patients were reinjected with radiophosphorus (without simultaneous administration of the lipotropic agents) and the determinations were repeated on the plasma lipids. Two months later, a third experiment was made, in which the effect of a single large dose of the substances was again studied, as in the first experiment.

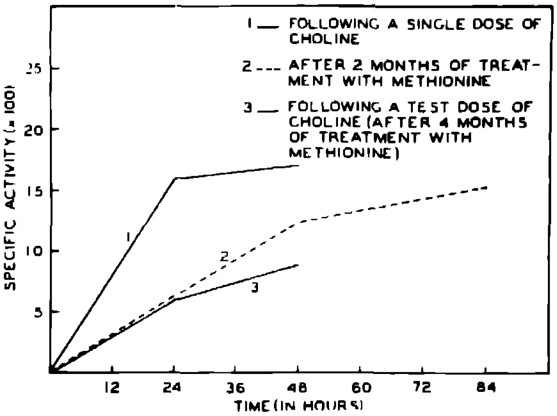

FIG. 1. Phospholipide turnover in a 31-year-old man with cirrhosis.

The results are shown in Figs. 1 and 2 and Table 1. In the two cirrhotic patients previously untreated, the specific activity values of the plasma lipids following the initial large dose of methionine or choline were considerably higher than the corresponding values found in the same patients in later periods, with or without administration of the massive dose of lipotropic substances. It seems logical to conclude that in these patients the initial large dose of the lipotropic substances actually caused a marked increase in the rate of phospholipide turnover and that such an increase was no longer obtainable after prolonged therapy with methionine. This last finding is in keeping with similar results we have obtained in a number of other patients who were also treated with

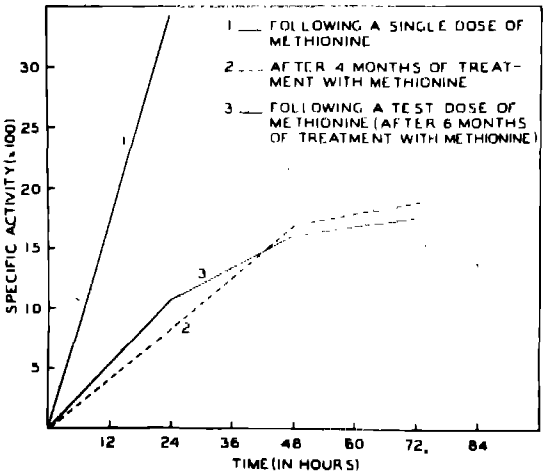

FIG. 2. Phospholipide turnover in a 36-year-old woman with cirrhosis.

methionine over a long period of time (*4*). In animals on choline-deficient diets, the administration of choline caused a marked stimulation of the turnover of liver and plasma phospholipides; this effect is smaller or undetectable in animals maintained on adequate diets. In other words, in experimental animals the stimulating action of a large dose is only evident when the supply of choline or choline precursor is insufficient.

These observations suggest a tentative interpretation of our present findings on human patients. One might postulate that a definite increase in the phospholipide turnover after the administration of a single large dose of choline or methionine reflects a condition of relative deficiency in lipotropic agents. This hypothesis deserves further investigation and we are continuing our study in order to arrive at a more definite conclusion.

In certain instances of chronic hepatitis, the use of lipotropic factors is thought to be of therapeutic value. This beneficial effect is attributed largely to a stimulatory action on the formation of phospholipides. An increase in the turnover of phospholipide in plasma was noted in two patients with portal cirrhosis who received a large dose of choline or methionine. This effect was no longer demonstrable after prolonged treatment with lipotropic agents, although the patients exhibited clinical and laboratory evidence of marked improvement.

It is suggested that the stimulation of phospholipide turnover caused by a single large dose of choline or methionine may indicate a deficiency of lipotropic material, and thus provide an estimate of the anticipated response to the treatment of cirrhosis with lipotropic substances.

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Evidence for the Conversion of Carbon Monoxide to Carbon Dioxide by the Intact Animal

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Conversion of CO to CO_2 by animal tissues was suggested and to some extent demonstrated by Fenn and Cobb (*5*) to account for the marked increases in gas consumption observed when isolated tissues, particularly muscle, were exposed to an atmosphere containing about 80% CO in oxygen. The phenomenon was confirmed by Schmitt and Scott (*9*) and shown to be superimposed on inhibition of the cytochrome-cytochrome oxidase system by Stannard (*10*). The ability of an intact animal to accomplish this conversion, however, has never been demonstrated. In fact, there have been numerous arguments against the presence of such a phenomenon (*6, 7*), the most recent of which is found in the results of Tobias *et al.* (*11*), in which radioactive carbon (as $C^{14}O$) was employed. They found that less than 0.1% of the CO lost from the blood could be recovered as $C^{14}O_2$ in the expired air.

TABLE 1

Disappearance of CO from Closed Chamber (60 Liters) with and without Turtles*

Exp.	Time†	Total weight of turtles	Initial CO concentration	Amount consumed With turtles	Amount consumed Control	Amount consumed Difference	CO consumed
	days	g	%	ml	ml	ml	%
1	8	2080	0.023	5.92	0.00	5.92	41
2	7	4826	0.020	7.71	1.20	6.51	52
3	13	4880	0.038	12.03	2.68	9.35	48
4	11	4662	0.047	14.86	1.08	13.78	49
5	10	2946	0.075	13.30	0.00	13.30	30

* Gasometric experiments, values expressed at STP.

† Number refers to duration of *each* period, control and experimental.

With the availability of C^{14} and recent refinements in methods for the determination of very small amounts of CO, it was considered of interest to repeat the experiments done in this laboratory with isolated tissue and to extend them to the intact animal. The results with isolated tissue have been reported elsewhere (*3, 4*). Suffice it to say that the oxidation of CO to CO_2 by skeletal and cardiac muscle observed earlier by indirect gasometric and volumetric procedures was quantitatively reproduced in direct experiments measuring conversion of $C^{14}O$ to $C^{14}O_2$.

In the experiments with intact animals reported here, two methods were applied: (a) gasometric measurement of the CO disappearing from a closed chamber, using a modification of the extremely sensitive Roughton-Root technique (*8*), and (b) collection of the expired CO_2 from animals residing in an atmosphere containing CO, some of which was the radioactive $C^{14}O$, and measurement of radioactivity by the method of Bale, *et al.* (*1*).

Table 1 shows the amount of CO lost, measured by the gasometric method, in five experiments with turtles. Expired CO_2 was collected in soda lime placed within the chamber, and oxygen was added automatically as needed from a small spirometer through a check-valve system. Any CO removed for sampling was replaced by introduction of an equal amount from a syringe. Samples were taken initially, after an equilibration period of 10–12 hr and then either daily or at the end of the test period.

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[1] Now at Abilene Christian College, Abilene, Texas.

It is clear that the amount of CO lost when the animals are present is large compared with that disappearing when only soda lime, food, accumulated feces and urine, etc. are present. It is also large compared with the amounts required to saturate blood and tissues at the CO tensions employed. The elapsed times are far greater than those necessary for equilibration of the gas with blood, tissues, and soda lime. Furthermore, samples taken at daily intervals indicated a more or less constant rate of disappearance (i.e., the CO does not all disappear during the equilibration period).

TABLE 2

DISAPPEARANCE OF CO FROM CLOSED CHAMBER (12.5 LITERS) WITH AND WITHOUT MICE*

Time	Total weight of mice	Initial CO concentration	Amount consumed		Rate of loss
			With mice	Control	
days	g	%	ml	ml	mm³/g/hr
4	246	0.071	4.49	0.13	0.20
4	294	0.089	8.16	0.84	0.26

* Gasometric experiment, values expressed at STP.

A similar experiment with mice is shown in Table 2. The initial concentrations were somewhat higher than in the experiments with turtles, but these represent only a moderately toxic level for mice. The CO concentration was determined initially, after an equilibration period of 10–12 hr, and again at the end of the experiment. The control period duplicated the experimental except for the absence of the animals. The data indicate disappearance of CO at a rate approximating 0.24 mm³/g body wt/hr.

The C^{14}-labeled CO was prepared by release of CO_2 from $BaCO_3$ having a specific activity of 384 μc per g of carbon. This CO_2 was reduced to CO after the method of Bernstein and Taylor (*2*). The conversion was practically quantitative, and this CO was used to prepare the mixture in the exposure chamber. The apparatus and conditions were otherwise similar to those in the gasometric experiment. Radioactive measurements were made with the CO_2 in gaseous form (*1*).

The results of the two experiments using mice are summarized in Table 3. While small amounts of radioactivity appeared in the alkali in the absence of the mice, due probably to solution of CO plus conversion to formate, it is obvious that the amounts of C^{14} appearing as $C^{14}O_2$ are many orders of magnitude higher in the presence of the animals. The phenomenon is clear, and the rate of CO oxidation calculated from isotope experiments agrees remarkably well with that obtained earlier by the gasometric procedure. While the specific activities in the collected CO_2 are low compared to the original CO, actually for each gram of carbon present as CO in the chamber, 22.3% and 19.3% respectively were converted to CO_2 in the two experiments.

The CO oxidation rate by the intact mouse is about 10 times that expected from a linear extrapolation of the rates obtained with isolated frog muscle at 80% CO to those expected at 0.07% CO. Allowing for the temperature difference (from 25° to 38° C), this indicates that mammalian muscle in the body effects this conversion at rates roughly equivalent to those expected from earlier work on isolated tissue. If applied to man, this rate would predict oxidation of CO at approximately 20 ml/hr if air containing 0.07% CO is breathed. It should be stated, however, that, if the rate observed by us in mice actually occurs in man, it should have been observable by the technique used by Tobias *et al.* (*11*). However, if the conversion is slow to start, the short times involved in their experiments might have prevented observation of the phenomenon.

TABLE 3

CONVERSION OF CO TO CO_2 BY MICE*

Time	Total weight of mice	Initial CO concentration	Activity measurements of $C^{14}O_2$ collected			Rate of conversion
			With mice		Control	
days	g	%	d/min $\times 10^3$	specific activity μc/g carbon	d/min $\times 10^3$	mm³/g/hr
2.67	57	0.07	459†	0.06	0.63	0.28
2.00	47	0.07	806	0.052	2.54	0.29

* Experiment with radioactive carbon monoxide ($C^{14}O$).
† That is, 459,000 disintegrations per minute.

The possible significance of these findings will be discussed in a more complete paper. Obviously, the mechanism of this reaction in tissues and its apparent limitation to muscle presents an interesting biochemical problem.[3]

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[3] Experiments with radioactive C^{14} in this paper were conducted in part under a contract with the U. S. Atomic Energy Commission at the University of Rochester Atomic Energy Project, and another between the Office of Naval Research and the University of Rochester. The cooperation of Drs. W. F. Bale, R. W. Helmkamp, and their assistants is gratefully acknowledged. This work is part of a program supported by the Air Materiel Command, Wright Field.

Comments and Communications

Color Standards for Biologists

There is a movement on foot to prepare a modern color chart, adequately standardized, and comprehensive enough to meet the requirements of all biologists, horticulturists, and technical agriculturists.

The subject was discussed last autumn by a group of biologists at the University of Toronto, who asked the National Research Council of Canada to set up a special committee to find out what Canadian biologists thought about color standards. The committee met on December 15, 1948, and drafted a questionnaire, which was later sent out to approximately 200 biologists and workers in related fields, mostly in Canada, but also a few in the United States, England, and France. One hundred and forty-one replies were received, a proportion which in itself demonstrates a lively interest in the subject.

The answers showed that Ridgway is the chart most familiar to the biologists and most used by them, followed by the Royal Horticultural Society's charts, and the *Munsell Book of Color*, in that order. The committee was not at all surprised at this result.

The question whether the worker would use a standard chart if it were available was answered in the negative by only 14 workers, mostly in the fields where color is not a major problem. As to the desirable form for such a publication, there was naturally a great diversity of opinion, reflecting the special interests of those who replied. A very large range of colors would undoubtedly be required, and in the interests of economy some loose-leaf or similar method of presentation would be essential, so that each worker might purchase only the range of colors useful in his specialty. A format suitable for field use was generally desired. There was almost unanimous agreement that each color must have a name, and so it appears that the numerical specification of color, familiar to physicists, is not yet acceptable to biological workers. The committee found it interesting to speculate on what the present state of descriptive biology might be, if the I.C.I. colorimetric system had been available to Linnaeus.

The final question referred to the permanence of color charts. Of those who answered, 35 were sure that their charts were changing significantly with the passage of time, 17 thought that they were not, and 8 were doubtful.

Discussing all these replies, the committee felt the results of this small survey showed clearly that many biologists are interested in a color standard prepared especially for their use. One excellent reason for the preparation of such a standard was suggested in one of the replies, which referred to the Plant Patents Act and the desirability of having some standard color reference for legal purposes.

A report on this questionnaire was presented to the Inter-Society Color Council at its New York meeting on March 9. The matter was referred to the Problems Committee of the I.S.C.C. for further study. Several members expressed the hope that some national organization of biologists would apply for membership in the I.S.C.C. and take an active interest in the project.

W. E. K. Middleton

Division of Physics,
National Research Council,
Ottawa, Canada

Scientific Book Register

Andronow, A. A., and Chaikin, C. E. (Solomon Lefschetz, Ed.) *Theory of oscillations.* Princeton, N. J.: Princeton Univ. Press, 1949. Pp. ix + 358. (Illustrated.) $6.00.

Beyer, Robert T. (Ed.). *Foundations of nuclear physics: facsimiles of thirteen original studies.* New York 19, N. Y.: Dover Publ., 1949. Pp. 272. (Illustrated.) $2.95.

Cameron, Edward A., and Browne, Edward T. *College algebra.* New York: Henry Holt, 1949. Pp. iii + 406. $3.00.

Carter, Herbert E. (Ed.) *Biochemical preparations.* (Vol. 1.) New York: John Wiley; London: Chapman & Hall, 1949. Pp. xi + 76. $2.50.

Case, Earl C., and Bergsmark, Daniel R. *College geography.* (3rd ed.) New York: John Wiley, 1949. Pp. x + 790. (Illustrated.) $5.00.

Hodges, Margaret B. (Ed.) *Social work year book 1949: a description of organized activities in social work and in related fields.* (10th issue.) New York: Russell Sage Foundation, 1949. Pp. 714. $4.50.

Lefschetz, Solomon. *Introduction to topology.* Princeton, N. J.: Princeton Univ. Press, 1949. Pp. viii + 218. (Illustrated.) $4.00.

Milne, E. A. *Kinematic relativity: a sequel to relativity, gravitation and world structure.* New York: Oxford Univ. Press; Oxford, Engl.: Clarendon Press, 1948. Pp. vi + 238. $6.50.

Pace, Edgardo. *Le vitamine: la chimica, la tecnica farmaceutica, l'azione biologica, i metodi di estrazione e di sintesi.* Milan, Italy: Ulrico Hoepli, 1949. Pp. xii + 422. (Illustrated.) 2,000 lire.

Rosseland, Svein. *The pulsation theory of variable stars.* New York: Oxford Univ. Press, 1949. Pp. viii + 152. (Illustrated.) $5.00.

Sisam, Charles H. *Analytic geometry.* (Rev. ed.) New York: Henry Holt, 1949. Pp. xvi + 304. $2.40.

NEWS and Notes

The Interstate and Foreign Commerce Committee of the House of Representatives endorsed the **National Science Foundation bill, H. R. 4846,** on June 13 and recommended its passage by the House of Representatives. Scientists interested in the establishment of the Foundation can now inform their Representatives that they too recommend the passage of H. R. 4846.

The American Medical Association has appointed five medical educators as its representatives at congressional committee hearings in Washington on national health insurance legislation. They are: **Creighton Barker,** Yale Medical School; **Donald Grigg Anderson,** dean of the Boston University School of Medicine; **William Harvey Perkins,** dean of Jefferson Medical College, Philadelphia; **William Shainline Middleton,** dean of the University of Wisconsin's Medical School; **Herman G. Weiskotten,** dean of the College of Medicine, Syracuse University.

Paul E. Klopsteg, director of research at Northwestern University Technological Institute, has been elected chairman of the board of governors of the Argonne National Laboratory; **Warren Johnson,** chairman of the Department of Chemistry at the University of Chicago, was elected vice chairman.

Selig Brodetsky, formerly professor of mathematics at Leeds University, England, has been appointed president of the Hebrew University, Jerusalem. Dr. Brodetsky succeeds the late **Judah Magnes.**

Eugene W. Scott, assistant executive secretary of the Research and Development Board of the National Military Establishment, has been appointed executive secretary of the Interdepartmental Committee on Scientific Research and Development.

George Herman Wise has been appointed head of the Nutrition Section of the Department of Animal Industry at North Carolina State College.

Harold M. Skeels has joined the staff of the National Institute of Mental Health, U. S. Public Health Service. Dr. Skeels has been assigned to the Community Services Branch of the institute for duty as mental health consultant in clinical psychology in San Francisco.

Visitors to U. S.

Fritz Feigl, analytical chemist with the Laboratory of Mineral Products of the Brazilian Ministry of Agriculture, Rio de Janeiro, will take part in the Second Annual Analytical Symposium sponsored by the American Chemical Society's Division of Analytical and Microchemistry and the society's publication *Analytical Chemistry,* to take place at Wesleyan University, Middletown, Connecticut, on June 24–25. His subject will be "The Role of Organic Reagents in the Chemistry of Specific, Selective, and Sensitive Reactions."

Visitors at the National Bureau of Standards during the week of May 23–27 included **C. B. Amphlett,** of the Atomic Energy Research Establishment, Harwell, England; **H. A. Wills,** of the Australian Commonwealth Department of Supply and Development, Division of Aeronautics; and **J. Yofe,** head of the Chemical Laboratory of the Standards Institution of Israel.

Lord Horder, chairman of the Empire Council on Rheumatism, and physician to King George VI of England, lectured at the International Congress on Rheumatism in New York City on May 30, and at the convention of the American Medical Association in Atlantic City, June 6–10.

Segismundo Gerszonowicz, director of the Instituto de Electrotecnica, University of Montevideo, who has been visiting lecturer at the Graduate School of Engineering, Harvard University, will return to Montevideo this month.

Grants and Awards

The University of California School of Medicine has awarded $7,500 to Abraham White, chairman of the Department of Physiology and Chemistry. Dr. White will investigate the biochemistry of normal and malignant lymphocytes in an effort to further understanding of one type of leukemia.

The **Patron's Medal of the Royal Geographical Society of Great Britain** has been awarded to Hans Pettersson, of the University of Gothenburg, Sweden, for a recently completed deep-sea expedition during which he made a number of oceanographical discoveries.

Fellowships

The American Cancer Society, in conjunction with the British Empire Cancer Campaign, announces a number of **British American Exchange Fellowships in Cancer Research.** These fellowships are open to American citizens who possess the degree of M.D., Ph.D., or D.Sc. and will provide specialized training in Great Britain; an equal number of young British scientists will be selected for training in this country. The fellowships, to be awarded by the society upon recommendation of the Committee on Growth of the National Research Council, will be granted for a period of one year at $4,020, with travel allowance of $600. Applications may be procured from and submitted at any time to the Executive Secretary of the Committee on Growth, Division of Medical Sciences, National Research Council, 2101 Constitution Avenue, Washington 25, D. C. The time of training will be arranged at the convenience of the institution and the fellow.

Colleges and Universities

California Institute of Technology dedicated its new $407,000 Earhart Plant Research Laboratory on June 7. Frits Went, professor of plant physiology in the Biology Division, is director of the laboratory.

By control of the temperature, humidity, light, and gas content of the air within the laboratory, a wide range of climatic conditions will be simulated to study their effects on plant growth. All greenhouses are equipped with de-ionized water and compressed air and are kept sterile. A prefocused camera, containing enough film for eight hundred pictures, will photograph plants at desired intervals. Time will be recorded in centidays—periods of 14 minutes and 24 seconds each. Clocks are so placed that they will appear in each photograph and record the exact time of exposure. Research at the laboratory is aimed at matching plants to climate for better crop production.

Northwestern University geographers will begin a one-year study of Puerto Rico's agricultural problems on July 1. Clarence F. Jones, professor of geography, will direct the program, aided by Simon Rottenberg, director of the Social Science Research Center of the University of Puerto Rico; Rafael Pico, chairman of the Puerto Rican Planning, Urbanizing, and Zoning Board; and G. Donald Hudson, chairman of Northwestern's Department of Geography. The program will be supported by a $16,000 grant from the University of Puerto Rico and the board. The project, which involves land classification and a study of present and future use of the land, is an effort to solve the island's major problem—population pressure on the land. It is expected that the project will also provide basic knowledge applicable to other humid tropical areas.

The San Gorgonio Section of the American Chemical Society was recently formed at the University of California Citrus Experiment Station at Riverside. Linus Pauling, national president of the American Chemical Society, presented the charter to the new section and Frances Gunther, section chairman, gave an address on "Valence and Structure of Metals."

Meetings and Elections

The 12th International Conference on Public Education will be held in the Palais Wilson, Geneva, July 4–12 under the sponsorship of Unesco and the International Bureau of Education. Techniques used by various countries for teaching natural science, geography, and reading will be reviewed. Seventy-three states have been invited to send delegates.

A communication received from the secretary general of the **Seventh International Botanical Congress,** to be held in Stockholm, Sweden, July 12–20, 1950, states that presessional excursions will start on June 27 and postsessional excursions will end on August 9. Communication No. 2 from the Organizing Committee, containing the preliminary outline of the program and preliminary plans for the excursions, may be obtained from Dr. Ewart Aberg, Secretary General, Uppsala 7, Sweden.

The 1949 Plant Science Seminar will be held at the University of Wisconsin School of Pharmacy August 21–27. Persons interested in attending should write to Dr. Joseph V. Swintosky, Local Secretary, Plant Science Seminar, University of Wisconsin School of Pharmacy, Madison 6, Wisconsin.

The Pennsylvania Academy of Science elected the following officers at its 25th anniversary meeting April 15–16: Richard Foose, of the Geology Department, Franklin and Marshall College, president; and Harry K. Lane, of Hershey Junior College, secretary-treasurer.

The summer meeting of the academy will be held at Stroudsburg and Buck Hills Falls in August.

The Iowa Academy of Science, at its 61st meeting on April 15–16, elected as 1949–50 officers: J. B. Culbertson, Cornell College, president; Paul S. Helmick, Drake University, vice president; F. G. Brooks, Cornell College, editor; and Cornelius Gouwens, Iowa State College, secretary-treasurer and representative on the AAAS council.

The North Dakota Academy of Science elected the following officers for the academic year 1949–50 at its 41st annual meeting held jointly with the Red River Valley section of the American Chemical Society, May 6–7: president, Ralph E. Dunbar, North Dakota Agricultural College; and vice president, A. K. Saiki, University of North Dakota. G. A. Abbott, of the university, was reelected secretary-treasurer. J. Alex Munro, of the Agricultural College, was renamed representative on the AAAS council.

The Kentucky Psychological Association elected the following officers at its annual meeting held May 21 at the University of Kentucky: president, George A. Muench, University of Louisville; president-elect, Frank A. Pattie, University of Kentucky; and secretary-treasurer, Priscilla Alden, Nichols Veterans Hospital.

The University of Pennsylvania Chapter of the Society of the Sigma Xi elected the following officers to serve during the academic year 1949–50: president, Gaylord P. Harnwell, Department of Physics; vice president, Eugene P. Pendergrass, Department of Radiology of the hospital; and secretary, Harry E. Morton, Department of Bacteriology, School of Medicine. S. Reid Warren, Moore School of Electrical Engineering, continues as treasurer.

Academic Press, Inc. announces the publication of a new journal *Experimental Cell Research,* sponsored by the **International Society for Cell Biology.** The new journal will publish papers dealing with experimental analysis of the activity, structure, and organization of the cell and its sub-units, including work on virus. Technical or theoretical papers aiming at the further development of methods in the field of experimental cytology will also be included. Papers may be submitted in English, French, or German.

Experimental Cell Research will be edited by Törbjorn Caspersson, Stockholm; Honor Fell, Cambridge, England; John Runnström, Stockholm; Francis O. Schmitt, Cambridge, Massachusetts; Paul Weiss, Chicago, Illinois; and Ralph W. C. Wyckoff, Bethesda, Maryland. J. F. Danielli, London, will act as editor of communications for the society.

Authors residing in the western hemisphere should send their papers to U. S. editors; those residing in the British Isles should mail theirs to Dr. Honor Fell, Cambridge; papers originating in other countries should be forwarded to the Scandinavian editors.

One volume, consisting of four issues, will be published annually.

The Chicago Natural History Museum's 15th Southwest Archaeological Expedition left June 8 for west central New Mexico. Paul S. Martin, chief curator of the museum's Department of Anthropology, heads the expedition; John B. Rinaldo, associate in archaeology, is his assistant. The expedition will work in Pine Lawn Valley, about one hundred miles north of Silver City, where they will resume their hunt for traces of prehistoric inhabitants during the various periods between 3000 B. C. and 1000 A. D.

The New School for Social Research in New York City has expanded its science program to include a group of six courses on biochemistry to be offered to the public free of charge this fall. The lectures will be given jointly by the New School and the Institute for Muscle Research, under the direction of Albert Szent Gyorgi, Hungarian scientist. The courses will run from seven to 16 weeks. The first two. "Dynamics of Living Things," and "Dynamics of Muscle as a Living System," are designed primarily for nonscientists and will emphasize the fusion of the sciences into a single unit based on the knowledge of the atom. Speakers scheduled for these lectures include Dr. Gyorgi and Otto Warburg, both of the Institute for Muscle Research; Otto Loewi, research professor of pharmacology, New York University College of Medicine; and Otto Meyerhof, research professor in physiology, University of Pennsylvania. These specialized courses will be presented mainly by the institute staff. The other four courses, designed more expressly for scientists, will cover "Biochemistry of Muscle," "Blood and Some Aspects of Its Functions," "Elementary Introduction to Quantum Mechanics and Some Biological Applications," and "Quantum Chemistry and Its Biological Applications."

David M. Delo, chief of Scientific Manpower for the Research and Development Group, Logistics Division, General Staff, U. S. Army, has been appointed the first executive director of the **American Geological Institute**, effective June 1.

The institute was established last November as an instrument of the National Research Council and will have its headquarters at the NRC, 2101 Constitution Avenue, Washington 25, D. C. Its activities will be carried on in conjunction with those of the NRC's Division of Geology and Geography. The primary objectives of the new institute are the advancement of geology and its application to human welfare through the cooperation of organizations active in the fields of pure and applied geology. Membership is open to all nonprofit organizations concerned with the earth sciences.

The initial member organizations, whose memberships total more than 10,000, are: American Association of Petroleum Geologists, American Geophysical Union, American Institute of Mining and Metallurgical Engineers, Geological Society of America, Mineralogical Society of America, Paleontological Society, Seismological Society of America, Society of Economic Geologists, Society of Economic Paleontologists and Mineralogists, Society of Exploration Geophysicists, and Society of Vertebrate Paleontology.

Officers of the institute are A. I. Levorsen, dean of mineral sciences, Stanford University, president; W. B. Heroy, Beers and Heroy, Dallas, vice president; and Earl Ingerson, U. S. Geological Survey, Washington, D. C., secretary-treasurer.

Recently Received—

Manual of the International Statistical Classification of Diseases, Injuries, and Causes of Death: Sixth Revision of the International Lists of Diseases and Causes of Death; Adopted 1948. (Vol. 1.). Published by World Health Organization, 350 Fifth Avenue, New York 1, N. Y.

Tepexpan Man by Helmut de Terra, Javier Romero and T. D. Stewart. (Viking Fund Publications in Anthropology, No. 11.) (Illustrated.) Order from Viking Fund, 14 East 71st Street, New York 21, N. Y. $3.00.

Industrial Uses of Radioactive Materials: A Selected Bibliography. Available without charge from Arthur D. Little, Inc., Cambridge 42, Mass.

Thomas Bartholin by Axel Garboe. (Acta Historica Scientiarum Naturalium et Medicinalium, Vol. V.) In Danish. Einar Munksgaard, Morregade 6, Copenhagen, Denmark. 21 kroner.

Utilization of Sucrose by the Mammalian Organism by Walter W. Wainio. (Scientific Report Series No. 12.) Copies obtainable from Sugar Research Foundation, Inc., 52 Wall Street, New York 5, N. Y.

Acids, Bases, and Non-Aqueous Systems by Ludwig F. Audrieth. (23rd Annual Priestley Lectures at Pennsylvania State College.) Issued by Phi Lambda Upsilon, Department of Chemistry, Pennsylvania State College, State College, Pa. $2.00.

Scientists: Supply and Demand (1), and Opportunities in the Medical Profession (2). Prepared by Western Personnel Institute, 30 N. Raymond Avenue, Pasadena 1, Calif. 50¢ and $1.00 respectively.

Make Plans for—

American Society for Agricultural Engineers, June 20–23, East Lansing, Michigan.

American Dairy Science Association, June 21–23, University of Minnesota, Minneapolis.

International Association for Dental Research, American Division, June 24–26, Chicago.

American Association of Dental Schools, June 27–29, Drake Hotel, Chicago.

American Society of Mechanical Engineers, June 27–30, San Francisco, California.

American Society for Testing Materials, June 27–July 1, Atlantic City, New Jersey.

American Home Economics Association, June 28–July 1, San Francisco, California.

Loyalty and Security Problems of Scientists: A Summary of Current Clearance Procedures[1]

Scientists' Committee on Loyalty Problems,[2]

A Committee of the Federation of American Scientists
14 Battle Road, Princeton, New Jersey

A SCIENTIST who is considering a job with the federal government, or with an industrial laboratory or university which has financial support from the government, may need loyalty or security clearance from the appropriate government agency. If the work is "classified,"[3] he will certainly need security clearance, and if he works for the government directly on any kind of job, loyalty clearance is required. But even if he anticipates only unclassified work, either in industry or at a university, he may still need some sort of clearance.

The clearance requirements and the procedures involved are varied and not well understood by most scientists, perhaps not even by a prospective employer. Since government-supported research is rapidly becoming the rule rather than the exception, there is a growing need for scientists to familiarize themselves with a type of problem which has hitherto been in the province of the legal profession.

Among the many questions about which there is considerable confusion is the distinction between *loyalty* and *security* clearance. According to current usage of the term, loyalty clearance refers to the requirements placed upon all government employees (more than two million) by the President's order of March 21, 1947 (7). According to this order, *all* persons employed by or seeking employment from the federal government must be subjected to a loyalty investigation; no distinction is made between persons who do classified work and those who do not. On the other hand, security clearance refers to the special requirements of certain "sensitive security areas," and applies to persons who work with classified or restricted information. Factors considered in processing security cases include questions of loyalty but also include questions of personal reliability, emotional stability, etc. Altogether, six government agencies—viz., the Atomic Energy Commission, the Departments of Army, Navy, and Air Force, the State Department, and the Central Intelligence Agency—have their own separate security clearance procedures. The last two agencies mentioned do not ordinarily employ scientists. In addition, persons working on contracts from these agencies must have security clearance if they have access to classified or restricted information. The clearance procedures of the Atomic Energy Commission apply to both commission employees and employees of AEC contractors. The three departments of the National Defense Establishment, however, have a different set of procedures for employees of their contractors.

Although these security clearance procedures apply in principle only to persons who actually have access to classified or restricted information, some industrial laboratories and even some university laboratories have considered it convenient, from an administrative point of view, to request security clearance of *all* their employees, regardless of whether or not they are doing classified work. Thus, the impact of the security program is being felt by a relatively large group of scientists.

THE LOYALTY PROGRAM

Among the numerous government departments and agencies which administer the requirements of the President's loyalty order, the Departments of Commerce, Interior, Agriculture, Navy, and Air Force, the Federal Security Agency, and the Federal Communications Commission are of particular interest to scientists. Such bureaus as the Bureau of Standards, the Civil Aeronautics Administration, the Weather Bureau, the Bureau of Mines, the Geological Survey, the Public Health Service, the National Institutes of Health, and the Food and Drug Administration are included in the departments and agencies mentioned. The formal loyalty procedures of all these are uniform, although the administrative personnel involved naturally varies considerably.

The procedure used is this. The Federal Bureau of Investigation makes a check of all available records—FBI, Civil Service Commission, Military and Naval Intelligence, and House Committee on Un-American Activities—to see whether there is any derogatory information concerning the individual. If no such information is found, nothing further is done. Whenever any derogatory information is discovered, the FBI carries out a "full field investigation" and then turns the file over to the agency or department in the case of employees or to a Regional Loyalty Board of the Civil Service Commission in the case of applicants. Each federal department and agency has set up a loyalty board to review cases of their employees; adverse decisions made by these boards may be appealed to the department or agency head or a person designated by him. Final appeals from both employees and applicants may be made to a special Loyalty Review Board set up in the Civil Service Commission. This Loyalty Review Board has acted as the administrative head of the entire loyalty program (*8*).

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[1] This article was submitted to the government agencies involved for comments and criticism.

[2] Members of the committee are L. Spitzer, Jr., chairman, W. A. Higinbotham, associate chairman, A. S. Wightman, secretary, D. R. Hamilton, treasurer, D. Bohm, R. Britten, R. E. Bush, E. G. Butler, A. Einstein, L. P. Eisenhart, S. A. Goudsmit, M. S. Livingston, S. Mudd, D. Pines, O. Veblen, and I. Wolff.

[3] "Classified" information is that which has been adjudged "top secret," "secret," "confidential," or "restricted." (The Atomic Energy Commission uses the term "restricted" instead of "classified.")

As of September 18, 1948, 2,136,501 loyalty investigations had been completed and 4,303 "full field investigations" conducted. The results of hearings held as of September 18, 1948, are shown below (*3*):

Hearing Board	*Favorable*	*Unfavorable*
Agency boards (employees)	1122	69
Agency head (appeals by employees)	6	15
Regional CSC board (applicants)	159	17
Loyalty Review Board (final appeal)	2	6

In all these loyalty hearings, the employee or applicant was presented with a statement of the charges against him and was permitted to be represented by a lawyer and to present evidence through witnesses or otherwise. Strict legal rules of order, however, were not adhered to; in particular, confrontation or cross-examination of witnesses was seldom allowed. The standard for refusal of or removal from employment, according to the original executive order, is that ". . . on all the evidence, reasonable grounds exist for belief that the person involved is disloyal. . . ." Activities which were to be considered included sabotage, espionage, treason, advocacy of revolution by force, unauthorized disclosure of information, and serving the interest of another government. In addition, the doctrine of "guilt by association" was included, since "Membership in, affiliation with or sympathetic association[4] with . . ." organizations declared "subversive"[5] by the Attorney General were possible causes for a finding of disloyalty. Organizations so designated have been given no avenue of appeal. In the case of membership in the Communist Party and certain other organizations, the Attorney General has declared that dismissal was mandatory under the Hatch Act (Public Law 252—76th Congress) (*13*).

THE ATOMIC ENERGY COMMISSION

The Atomic Energy Act of 1946 (*15*) requires the AEC to secure an FBI report on all persons having access to restricted data and to determine that such access will not endanger national security. On April 15, 1948, the commission announced its "Interim Procedure" for security clearance of employees (*1*). The FBI report is first reviewed in the appropriate AEC field office; the Manager of Directed Operations may grant or deny clearance or may refer the case to the Director of Security in Washington.

To aid the manager in reaching a decision, the commission set up a set of criteria on January 5, 1949 (*9*). Two categories of information were described. The first category included classes ". . . which establish a presumption of security risk," and in such cases the local manager can deny clearance or refer the case to the Director of Security in Washington. Included in this category are sabotage, espionage, treason, sedition, association with foreign agents, membership in organizations declared subversive by the Attorney General (provided the individual did not withdraw when the organization was so identified, or otherwise establish his rejection of its subversive aims), advocacy of revolution by force, deliberate omission of "significant information" from personnel questionnaires, violation of security regulations, insanity, conviction of criminal offenses, and habitual drunkenness. The second category includes more questionable types of information; in these cases the local manager may grant or deny clearance. Included in this list are "sympathetic interest in totalitarian, fascist, communist, or other subversive political ideologies," "sympathetic association" with communists or members of other "subversive" organizations (as defined by the Attorney General), identification with subversive "front" organizations or organizations "infiltrated" with subversive persons (when there is additional evidence that the individual's views agree with those of the subversive "lines"), residence of relatives in certain foreign countries, "close continuing associations" with persons having "subversive interests and associations," (as defined above), conscientious objection to war except on religious grounds, manifest carelessness, and homosexuality.

When a preliminary decision has been made to refuse security clearance, an employee is presented with a statement of charges and is permitted a hearing before a local Personnel Security Board, which then makes a recommendation to the Manager of Directed Operations. If the decision is still unfavorable to the employee, he may appeal to the Personnel Security Review Board, which until recently was headed by ex-Supreme Court Justice Owen J. Roberts. Charles Fahy, former Solicitor General of the United States, is now head of this board.

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[4] This term is not further defined (See *6*, page 41).

[5] See *6*, page 30.

According to the Fifth Semiannual Report of the AEC (January, 1949) (*10*), the Commission has taken action on more than a hundred thousand candidates for clearance, but fewer than two thousand of these involved serious questions concerning eligibility. No recent figures on the number of hearings held have been released, but as of July 15, 1948, fifteen hearings for employees were conducted by local boards (*11*). At that time, five were granted clearance, and one was refused clearance.

Applicants for AEC jobs or for jobs with AEC contractors have not been allowed any of these procedural safeguards, however. Except in a few cases, no statements of charges or hearings of any sort have been given. During recent months the commission has been considering extending its procedures to include applicants (*10, 11*), but at the date of this writing no action has been taken.

DEPARTMENTS OF ARMY, NAVY, AND AIR FORCE

Public Law 808, passed by the 77th Congress, gave the "power of summary dismissal" to the heads of these departments and thus established the basis for security clearance requirements (*14*).

Like all other government employees, civilian employees of the Army Department are required to have a loyalty clearance in accordance with the President's order. The Army may require a more complete investigation of employees to be assigned to sensitive activities, however, and such clearance is called security clearance (*5*). The removal procedures of Executive Order 9835 are not followed in any case. If an employee is discharged he is given at that time a statement of reasons for the action and may appeal the decision to the Secretary of the Army's Security Review Board. As of October 1, 1948, 79 employees of the Army Department had been removed under these procedures and 16 of them had been reinstated after appeal, according to information obtained from the Office of the Secretary of the Army.

The Department of the Navy requires only loyalty clearance of *all* its employees, and the procedures used are similar to the loyalty procedures of other government agencies (*12*). When an employee has access to classified materials or information, however, security clearance is required, and in that case no hearings at all are provided. In accordance with the requirements of Public Law 808, passed by the 77th Congress, the employee is presented with a statement of the reasons for his dismissal and he may file a statement protesting such action if he wishes.

The Department of the Air Force has a still different set of procedures in which loyalty and security are considered together (*2*). A finding of disloyalty necessarily implies that the employee is a "security risk" but not vice versa, according to these procedures. In all cases, two hearings are possible: one before a Loyalty-Security Hearing Board and, in the event of an adverse decision, another before the Loyalty-Security Review Board. Further, a finding of disloyalty may be appealed to the Civil Service Com-

TABLE 1

SUMMARY OF PROCEDURAL SAFEGUARDS

	Loyalty program		Security programs					
			AEC					
	E*	A†	E*	A†	Army	Navy‡	Air Force	IERB§
Statement of charges presented to accused?	Yes	Yes	Yes	No	Yes	Yes	Yes	No
Hearing held before action taken?	Yes	Yes	Yes	No	No	No	Yes	No
Number appeal hearings available.	2	1	1	0	1	0	1	1
Civilian boards?	Yes	Yes	Yes	....	Yes	....	Yes‖	No
Counsel permitted?	Yes	Yes	Yes	....	Yes	....	Yes	Yes
Can accused introduce evidence?	Yes	Yes	Yes	....	Yes	....	Yes	Yes
Confrontation of witnesses permitted?	No	No	No¶	....	No	....	No	No
Transcript of hearing given to accused?	Yes	Yes	Yes	....	Yes	....	Yes	No
Are hearings unclassified?	Yes	Yes	Yes	....	Yes	....	Yes	No

* E—Employee.

† A—Applicant.

‡ Most Navy Department cases are loyalty cases, not security cases (See Navy Civilian Personnel Guide 20).

§ Industrial Employment Review Board (Army, Navy, and Air Force contracts).

‖ The Air Force regulations stipulate that a majority of the board be civilians (See Air Force Regulation No. 40-12. September 15, 1948).

¶ Confrontation has been permitted in some cases. (See AEC Fourth Semiannual Report.)

mission Loyalty Review Board. However, even if the Loyalty Review Board issues a favorable decision, the department may still consider the employee to be a security risk.

Applications for jobs in these three departments are handled by the Civil Service Commission and so loyalty clearance is required, as in the case of other government departments and agencies described before. Once employed, however, a person may require additional security clearance under the procedures just stated.

ARMY-NAVY-AIR FORCE CONTRACTS

The Army, with the concurrence of the Navy and Air Force, has set up security clearance procedures for employees of contractors of the Army, Navy, and Air Force (4). Designated military officials may grant clearance directly, but doubtful cases are referred to the Army-Navy-Air Force Personnel Security Board, which may direct that the employee be discharged or suspended. This board holds no hearings. Any action may be appealed by the person involved to the Industrial Employment Review Board, in the office of the Provost Marshall General. A hearing before this board is possible only in Washington, D. C. The board consists of representatives, generally military men, from each of the three departments. No provision is made for the presentation of charges to the individual. The entire hearing is classified and no records or notes on the hearing may be kept by the individual or his lawyer. No further appeals are possible.

All of the procedures that have been described here differ from ordinary legal procedure in this country in at least four major respects (6): (1) no separation between the executive and judicial responsibilities is made in the processing of any loyalty or security cases, (2) no provision is made for a hearing board to write a specific finding of fact after a hearing, (3) confrontation and cross-examination of adverse witnesses are rarely permitted, and (4) the hearings are always closed to the public.

The procedural safeguards, the rights and privileges of individuals, are of particular interest to those scientists who may be involved in clearance problems. Thus, the chief items of the various procedures are summarized in Table 1. Such a condensation clearly cannot be used as the sole basis for judging and comparing various procedures, but may be useful as an index for further inquiry.

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Biological Synthesis of Radioactive Silk[1]

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FIBROIN, THE PROTEIN OF SILK, has been a classical object of study in attempts to elucidate the structure of proteins because it is stable and easily isolated and its composition is constant. Numerous and detailed analyses of its component amino acids (1–3) have revealed that glycine and alanine are present in exceptional concentrations, accounting, in fibroin hydrolyzates, for about three-quarters of the total number of amino acid residues and for about two-thirds of the total weight of the residues (1, 2). These unusual properties of fibroin, and the availability of C^{14}-labeled glycine and alanine

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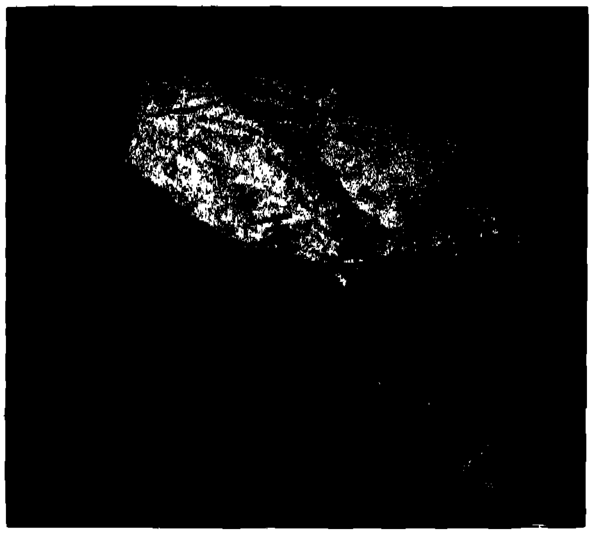

FIG. 1. Cecropia cocoon with a pupal stage of the insect removed therefrom.

FIG. 3. Radioautograph of silk fibers teased from a radioactive cocoon (mg. 11 ×).

(*4, 5*), suggest a possible approach to the biological synthesis of a stable, homogeneous, radioactive protein.

As a first step in this direction we have tested the ability of the giant silkworm, *Platysamia cecropia*, to incorporate radioactive glycine and alanine into the silk it synthesizes. To this end, 0.05 cc of a mixture of radioactive glycine and alanine was injected into the body cavity of a mature silkworm (animal A). A total of 27,000 counts per minute was injected, as measured by an end window Geiger-Müller counter with a counting efficiency of about 8 percent under conditions described previously (*8*). The injection contained 0.013 mg of C^{14}-carboxyl-labeled glycine with an activity of 18,000 cpm and 0.02 mg of C^{14}-carboxyl labeled DL-alanine, with an activity of 9,000 cpm.

Following the injection, the silkworm continued to feed normally for 24 hours. It then began spinning the cocoon shown in Fig. 1. A thin piece of cocoon fabric, removed and placed under the Geiger-Müller counter, exhibited radioactivity. A similar result was obtained with a silkworm (animal B) injected with 0.05 cc of a solution containing 18,000 cpm in 0.04 mg of C^{14}-carboxyl-labeled DL-alanine alone.

Fragments of cocoon from each insect were placed against unexposed film (Du Pont dental film No. 552-1 and No. 552-2 [cf. *6*]) and stored for periods of one to four weeks in the dark. The films were then developed for seven minutes at 68° F. Invariably, radioautographs which revealed details of the pattern of the silk fibers were obtained (cf. Figs. 2 and 3).

In order to test whether the radioactivity of the silk was actually present in the component amino acids, a fragment of cocoon A (73 mg) was cut into small pieces and homogenized into tiny fragments in water. The suspension was precipitated in 10-percent trichloroacetic acid, washed with trichloroacetic acid, and hydrolyzed overnight in an autoclave with the aid of 6 N hydrochloric acid. The ninhydrin procedure (*7*) was then performed on the protein hydrolyzate. Duplicate counts of the barium carbonate precipitate revealed 160 and 150 cpm per 0.1 mM $BaCO_3$ (*8*). Thus the radioactivity was shown to be present in the α-carboxyl group of some amino acid associated with the silk fibers.

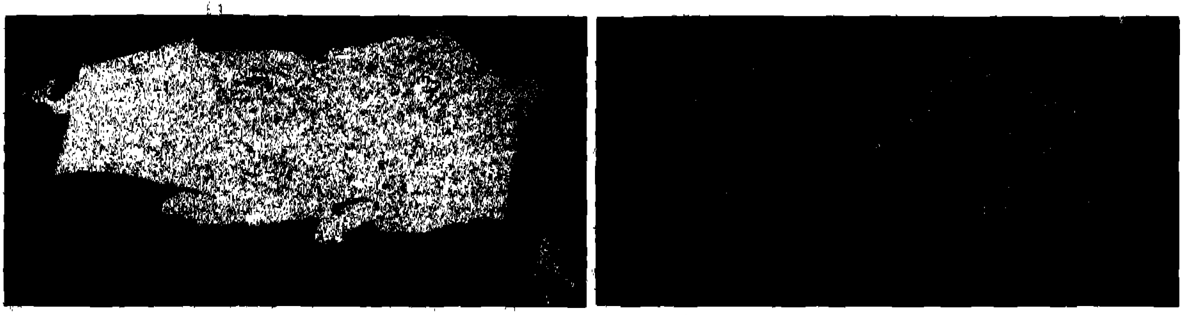

FIG. 2. a) Fragment of cocoon (mg. 3.5 ×). b) Radioautograph of the same fragment.

The possibility remained, however, that the labeled amino acids might be adsorbed onto the silk fibers, rather than incorporated into the peptide chain structure of the protein itself. Efforts were therefore made to dissolve the fibroin and determine whether or not the reprecipitated protein was still radioactive. There was not, unfortunately, a sufficient quantity of labeled silk to carry out such a procedure. Accordingly, 0.1 g of the labeled cocoon (animal A) was added to 0.9 g of inert silk, obtained from other cocoons, and the mixture was degummed by boiling with soap. The dried, degummed fibroin was then cut into tiny pieces with scissors and added to 43 cc of copper hydroxide-ethylene diamine solution [6 g $Cu(OH)_2$ and 3 g ethylene diamine in 100 cc of aqueous solution] (*2*). After ten minutes the silk had been partially dissolved. The suspension was then neutralized with 1.25 N acetic acid to pH 8, and filtered with suction. The clear, deep blue filtrate, containing dissolved silk, was added slowly to six volumes of acetone with stirring. The resulting precipitate was collected on a small Büchner funnel and washed with acetone and ether. The flaky, pale purple precipitate was suspended in 15 cc of water; the water turned a dark blue. The suspension was filtered onto a small Büchner funnel, and the light brown precipitate was washed with water and dried in an oven. Thirteen mg of this reprecipitated silk fibroin was hydrolyzed overnight in 1 cc of 6 N HCl in an autoclave. A ninhydrin determination was performed on the fibroin hydrolyzate, the evolved carbon dioxide being collected as barium carbonate and counted in the usual manner (*8*). There were 12.7 cpm per 0.1 mM barium carbonate when corrected to 0.1 mM thickness (5.4 mg per sq cm with our apparatus). Taking into account the tenfold dilution of the original labeled silk with unlabeled silk, there were 127 cpm per 0.1 mM of hydrolyzate of labeled silk fibroin.

As a result of these findings, we were encouraged to try an experiment *in vitro* on protein synthesis in the isolated silk gland of the insect. Two silkworms, in the final instar, were dissected and the four silk glands removed. These glands were incubated in a Warburg flask in 1.1 cc of Krebs-Ringer-phosphate medium of pH 7.4, which contained in addition 0.04 M sodium pyruvate and 0.37 mg of C^{14}-carboxyl-labeled glycine with an activity of 10,000 cpm. After 3½ hours' incubation at 37° C in an atmosphere of oxygen, the experiment was terminated. The glands were homogenized and washed, and the proteins were precipitated, hydrolyzed, and assayed for the presence of radioactivity. A total of 74 cpm was found in the 0.067 mM sample of $BaCO_3$, or 93 cpm per 0.1 mM of $BaCO_3$ as corrected to standard conditions. This experiment implies that the amino acids were incorporated into protein in the living silkworm gland *in vitro*. Since the fibroin was not isolated, there is no certainty, however, that silk rather than some other protein was synthesized under the conditions of the experiment.

The term "protein synthesis" is used in a broad sense. There remains the possibility that the labeled amino acids may have entered preformed fibroin molecules by "exchange" rather than by participation in a true synthesis of the fibroin molecule *de novo*. There may also be formation of side chain peptide bonds between the labeled amino acids and either amino or carboxyl groups not in the alpha position. These several processes may have conceivably all taken place under the experimental conditions.

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TECHNICAL PAPERS

The Conversion of β-Erythroidine to Derivatives of the Desmethoxy Series and Some Pharmacological Properties of Apo-β-Erythroidine[1, 2]

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β-Erythroidine differs from almost all other peripheral curariform agents in that it is much less effective when employed as the quaternary ammonium salt than when employed as the tertiary amine hydrochloride (*11*). Inasmuch as it is generally thought that the quaternary ammonium ion is very important in conferring curariform activity (*4*), the structural unit responsible for the curariform activity of β-erythroidine must, therefore, be of a different type from that of the usual curariform agent. We have made some preliminary investigations of β-erythroidine in the hope of establishing some relationship between structure and activity, and it is the purpose of this note to report the discovery of some new derivatives of β-erythroidine and to describe some of the unusual pharmacological properties of one of these derivatives, apo-β-erythroidine.

β-Erythroidine was first isolated and characterized by Folkers and Major (*8*). Following this excellent work, Folkers and Koniuszy (*6*) in 1939 and Folkers, Koniuszy, and Shavel (*7*) in 1941 reported on some chemical studies of β-erythroidine. As yet, no experimental details of this work have been published, and it is fair to say that the structure of β-erythroidine is still largely unknown.

In 1946 Dietz and Folkers (*5*) reported a spectrophotometric method of analysis for β-erythroidine based on the fact that the alkaloid, after treatment with sulfuric acid, gives a purple color with ferric chloride. We have investigated further the action of acids on β-erythroidine and have found that, depending on the conditions employed, any one of three different isomeric derivatives of β-erythroidine may be obtained. The conversion of β-erythroidine to these derivatives was accomplished by the following procedures.

When β-erythroidine ($C_{16}H_{19}NO_3$) was treated with hydrogen fluoride at room temperature there was obtained, after isolation and purification, a white, crystalline solid, mp 108–109° C, having the empirical formula, $C_{15}H_{15}NO_2$ (*Analysis*: Calculated for $C_{15}H_{15}NO_2$: C, 74.66; H, 6.26; found: C, 74.74; H, 6.06). This product differs from β-erythroidine by the elements of methanol (CH_4O), and it would appear to have been formed by the simple loss of a methoxyl group with introduction of a double bond. In support of this view β-erythroidine was found to contain one methoxyl group (*Analysis*: Calculated for $C_{16}H_{19}NO_3$: 1-OCH_3, 11.35; found: OCH_3, 11.10) whereas the product from treatment of β-erythroidine with hydrogen fluoride was found to contain no methoxyl groups. Therefore, we have named this product, desmethoxy-β-erythroidine. Desmethoxy-β-erythroidine does not give a color with ferric chloride.

On the other hand, when β-erythroidine was heated to 120° C with either phosphoric or sulfuric acid, the product isolated from the reaction mixture after this more drastic treatment was a solid, which, after crystallization from ethanol, melted at 132–132.5° C. This compound was shown (*Analysis*: found: C, 74.94; H, 6.27) to be isomeric with desmethoxy-β-erythroidine, but it has quite different properties and gives a violet color with ferric chloride. We have designated this compound, therefore, as apo-β-erythroidine.

Some idea of the relationship of desmethoxy-β-erythroidine to apo-β-erythroidine was obtained when it was found that phosphoric acid at 80° C converted β-erythroidine to desmethoxy-β-erythroidine and that desmethoxy-β-erythroidine, in turn, was converted by phosphoric acid at 120° C to apo-β-erythroidine. It appears that the conversion of β-erythroidine to apo-β-erythroidine involves rearrangement as well as the loss of a methoxyl group.

Attempts to purify apo-β-erythroidine by chromatography led to still another product. This new product, mp 146–147° C, although isomeric with apo-β-erythroidine and desmethoxy-β-erythroidine (*Analysis*: found: C, 74.52, 74.81; H, 6.20, 6.39) has quite different spectra and properties from either of them. For reference it has been named iso-apo-β-erythroidine. The nature of the structural relationships of these three desmethoxy derivatives of β-erythroidine is of considerable interest and will be discussed in fuller detail elsewhere.

Desmethoxy-β-erythroidine, apo-β-erythroidine, and iso-apo-β-erythroidine have been tested for pharmacological activity, and although desmethoxy-β-erythroidine and iso-apo-β-erythroidine presented little of interest, apo-β-erythroidine showed quite unusual properties.

An intraperitoneal injection of apo-β-erythroidine to mice in doses of 150 mg per kg caused flaccid paralysis and loss of postural reflexes. The hind legs and posterior half of the body became affected first and remained paralyzed longer than the front limbs and neck muscles. During paralysis respiration remained adequate but was decreased in rate and increased in depth. Faradic stimulation of the sciatic nerve caused contraction of the paralyzed limbs. Paralysis was not preceded by excitation and was followed by complete recovery of muscular power.

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[1] Aided by a grant from the National Foundation for Infantile Paralysis.

[2] We are grateful to Merck & Co., Rahway, N. J. for the β-erythroidine used in this study.

The paralyzing effect of apo-β-erythroidine was similar to that observed after administration of benzimidazole (9), myanesin (2), and glyketal (1). It differed from these agents in producing paralysis of much longer duration. The mean duration of paralysis with doses of 180 mg per kg was 6 min for myanesin and 35 min for apo-β-erythroidine. After 250 mg per kg of apo-β-erythroidine paralysis lasted for several hours. Death after toxic doses of apo-β-erythroidine was due to respiratory arrest. In mice the mean lethal dose was more than twice as large as the mean paralyzing dose.

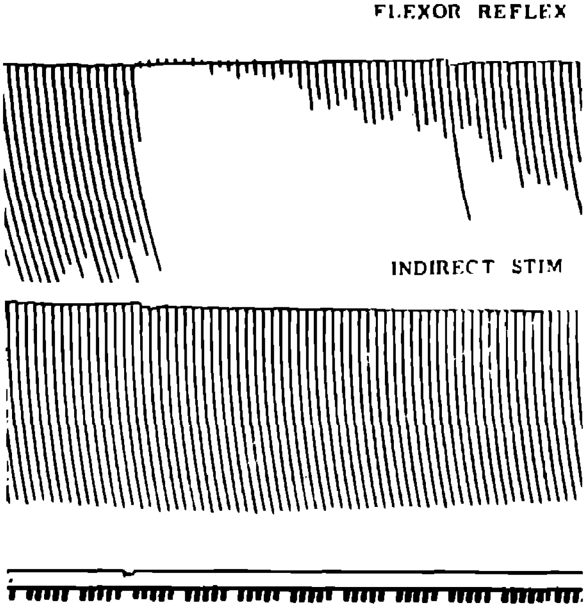

FIG. 1. Effect of apo-β-erythroidine on the flexor reflex and indirect excitability of the muscle. Tracing from above downwards: 1) flexor reflex; 2) stimulation of gastrocnemius muscle through its nerve; 3) signal line and 4) time at 10-sec intervals.

At the signal 20 mg of apo-β-erythroidine was injected into the external jugular vein.

Analysis of the pharmacodynamic effects of apo-β-erythroidine in cats showed that the compound did not block transmission at the myoneural junction. It produced paralysis by a depressant effect on the central nervous system. Two neuronal spinal reflexes such as the knee jerk were not affected but multineuronal reflexes such as the flexor reflex were selectively depressed by small doses of the drug. This effect together with the lack of curare-like action of the compound is illustrated in Fig. 1.

The results indicate that apo-β-erythroidine has a selective depressant action on the interneurons. It resembles in this respect other interneuronal blocking agents (1, 2, 9). The fact that four chemically different substances produce similar central effects and act at the same site is of great interest. They are likely to act by blocking some important but as yet unknown mechanism of transmission in the central nervous system. None of these substances interferes with the action of acetylcholine as a transmitter of nervous impulses.

It has been suspected for some time that β-erythroidine, apart from its curare-like action, also possessed central depressant properties (3, 10). These two properties have been dissociated in apo-β-erythroidine, which lacks the peripheral action but still retains the central depressant properties of β-erythroidine.

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Surface Action in 2,4-D Sprays[1]

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A number of workers (1–4) have reported increased toxicity when various substances are added to sprays of 2,4-dichlorophenoxyacetic acid used as an herbicide. Preliminary results in the summer of 1947, extensively corroborated since, show that the toxicity of these sprays may be increased several fold by adding various surface-acting substances, and suggest that some previously reported results may have been due to similar effects.

Commercial soapless powders with a base of sodium lauryl sulfate have been used most extensively as sur-

TABLE 1

YIELDS OF FLAX SEED WHEN SPRAYED WITH 2,4-D, WITH OR WITHOUT A WETTING AGENT

Spray	Surface tension of spray		Yields in bu/acre*	
	2,4-D only	Plus ⅛% "D"	2,4-D only	Plus ⅛% "D"
Water	72 dynes	28 dynes	10.4	17.4
Na salt—⅛ lb	58	28	18.6	*5.4*
—¼ lb	57	28	18.5	*12.2*
—½ lb	57	28	10.2	14.6
Amine —⅛ lb	58	29	15.4	*6.1*
—¼ lb	51	29	15.2	*10.7*
—½ lb	52	29	15.7	12.8
Ester —⅛ lb	34.1	30	11.7	11.2
—¼ lb	35.0	30	13.5	. . .
—½ lb	35.7	30	10.4	15.1

* Least significant difference (5%), 3.29 bu/acre.

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[1] Paper No. J1654, Iowa agric. Exp. Sta., Project 944.

face-acting compounds. The effects of adding ½% of one such preparation to various sprays used on flax at the rate of 10 gal per acre are shown in Table 1. The wetting agent alone had no effect, but when added to the sodium or amine salts of 2,4-D, the yields were reduced seriously at the heavier rates of 2,4-D. The appearance of the plots some 10 days after spraying suggested that the mixed sprays would be lethal, but the plants made enough late second growth to produce some seed. The wetting agent did not increase the toxicity of the ester formulation on flax, although in another experiment it did increase injury of corn. These plots were fairly free of weeds and all spray treatments reduced weed growth to an insignificant level.

TABLE 2

STALK REACTIONS AND YIELDS OF CORN SPRAYED WITH THE SODIUM SALT OF 2,4-D CONTAINING VARIOUS WETTING AGENTS

Wetting agent	Surface tension (dynes)	Stalk reaction score	Yield* bu/acre
None (check)	...	0.0	93.5
None (2,4-D)	51	0.7	94.5
"D"—⅛%	20.9	4.0	97.0
"D"—¼%	28.6	6.5	•76.7
"D"—½%	28.6	6.0	71.6
"D"—1%	28.9	7.8	53.8
"D"—2%	28.8	7.8	32.5
"V"—½%	29.9	6.2	81.3
"AO"—½%	28.0	5.5	64.5
"T"—½%	29.4	6.5	77.2
"TA"—½%	31.5	2.0	94.0

* Least significant difference (5%), 14.6 bu/acre.

Corn at the laying-by (10-leaf) stage was sprayed with the sodium salt (monohydrate) at ½ lb per acre in 47 gal water. The effects of various kinds and concentrations of wetting agents on plant reaction and yield are shown in Table 2. Yields again are in bushels per acre; stalk reaction is on a scale of 0 for no response to 10 for all the stalks twisted and bent nearly to the ground. All of the wetting agents except "TA" were approximately equal in giving a significant reduction in yield at ½%. "TA" was an experimental compound of a non-ionic type. In another experiment it was active on soybeans. Most of the surface-active compounds decreased the yield of corn by 10–15% when used alone because of the increased smut infection carried into the meristematic regions. The increased injury with increased percentages of agent "D" needs further investigation. It may represent direct toxicity at rates that reached 8 lb per acre, or it may mean more rapid surface action during the spraying operation. The wetting effect was identical whether the agent was mixed with the 2,4-D spray or applied to the leaves and allowed to dry before spraying with 2,4-D.

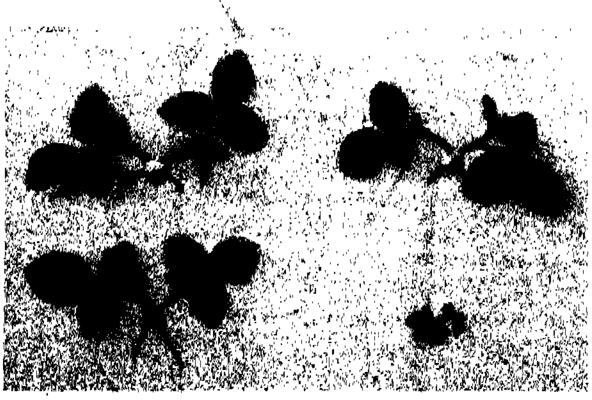

FIG. 1. New growth on sprayed soybean plants: upper left, water only; lower left, ½% "D"; upper right, 2,4-D, 500 ppm; lower right, 2,4-D + ½% "D."

The striking effect of a wetting agent in increasing the toxicity of 2,4-D on soybeans is shown in Fig. 1. The plants were wet with a 500-ppm solution of the sodium salt of 2,4-D, except for the growing point, which was covered with a waxed cap. The figure shows the new growth made in the week following spraying. Growing points, and most plants, died when the wetting agent was added, but recovered from the 2,4-D alone.

The toxicity of the sodium and amine salts of 2,4-D to corn, flax, and soybeans has been increased five or more times by adding about 1% of commercial non-soap wetting agents. Since several divergent types of agents have given the effect, it is probably not chemical in nature. Decreased surface tension and increased penetration of the sprays seem to be the probable answer, but it is not a simple relationship. A non-ionic wetting agent was ineffective on corn but active on soybeans. An ionic agent of the lauryl sulfate type gave increased response up to 2.0% of the agent in a dilute 2,4-D spray, even though the spray surface tension did not vary significantly after the first 0.05% of wetting agent was added.

The effect of the surface agent has been to increase the speed and severity of the plant reaction, but not necessarily to hasten death. No corn (moderately resistant) or flax (slightly resistant) plants have been killed by any of the treatments reported here. The effect on weeds is similar to the effect on crops. Resistant weeds show more injury but are not more readily killed. The main effect of the wetting agents, then, is to reduce the selective action of 2,4-D by which it is possible to kill susceptible weeds with little injury to resistant crops.

A special warning is necessary on this point because of the practice of using soap to reduce precipitation of amines in hard water. Excess soap gives results similar to those reported here. The new sequestering agents which prevent precipitation by tying up calcium insoluble acetates appear to be free of this objection.

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Hemolytic Disease in Newborn Dogs Following Isoimmunization of the Dam by Transfusions[1]

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Four different isohemagglutinins have been demonstrated in sera of dogs following transfusions with dog erythrocytes containing antigenic factors lacking in their own cells. The factors thus far identified serologically may conveniently be designated as "canine A, B, C, and D" and the corresponding antibodies as "canine anti-A, -B, -C, and -D." In our experience to date, A antibodies have been most easily produced in high titer, and in many respects their behavior *in vitro* is similar to that of Rh antibodies. Possible relationships between antigenic factors in dog red blood cells and factors present in erythrocytes of other species are under investigation. Pending completion of these studies, it is convenient to refer to dog cells containing the canine A factor as "Do-positive" and to cells lacking the canine A factor as "Do-negative."

Observations on hemolytic reactions following transfusion of Do-positive cells into immunized Do-negative recipient dogs and of anti-Do plasma into Do-positive recipients are described in separate reports (*2*, *4*, *5*). The object of this paper is to record the production of hemolytic disease in four Do-positive puppies born to a Do-negative bitch (mostly pointer) that had been immunized by transfusions of Do-positive cells and then mated with a Do-positive male (mostly German shepherd). Four Do-negative puppies in the same litter showed no evidence of hemolytic disease.

Erythrocytes of the four affected whelps were agglutinated by high dilutions of anti-dog-serum rabbit serum (positive direct Coombs' test), and were also agglutinated when suspended in undiluted normal dog serum, presumably because the cells were coated with Do-antibody. Unsuccessful attempts were made to separate the antibody from the puppies' cells by heating the cells at 48° to 56° C. Plasma drawn from the four unaffected Do-negative whelps agglutinated cells of the sire in a titer equal to that of the maternal serum at the time of delivery. Isoantibodies in the blood of the four affected Do-positive puppies, on the other hand, were apparently completely bound by cells, since plasma from these dogs did not agglutinate the sire's erythrocytes.

The maternal isoantibody titer fell from 1 : 64 (against the sire's cells suspended in autologous serum) at the time of mating to 1 : 4 at the time of delivery. The dam was not transfused during pregnancy, but was given 17 ml of the sire's fresh citrated whole blood intravenously immediately after delivery. Breast milk from the dam agglutinated the sire's red corpuscles in titers considerably lower than those found in the maternal serum during the postpartum period of rising antibody titer. Absorption of isoantibody from the milk by the puppies could not be demonstrated. It is significant that Do-antibodies could no longer be detected in plasma from the unaffected Do-negative puppies on the 9th day, and Coombs' tests on cells of Do-positive affected puppies became negative on the 12th day, despite the fact that all whelps suckled breast milk containing antibody for 24 days.

Erythrocytes from the four affected puppies showed increased susceptibility to lysis in hypotonic solutions of sodium chloride, but spheroidicity of these cells could not be detected in smears or wet preparations. Nucleated red blood cells and reticulocytes were more numerous in most of the smears prepared from blood of the affected puppies than in the Do-negative puppies, but in some instances the differences were not striking.

Only one Do-positive whelp showed icterus of skin and mucous membranes and was found to have distinctly increased concentration of bilirubin in the plasma. This puppy was moderately anemic. Another Do-positive puppy became severely anemic without developing jaundice. Neither icterus nor anemia of significance was found in the other two Do-positive puppies. The severely anemic whelp and a normal litter mate were sacrificed for histologic studies on the third day. The affected animal showed splenomegaly and more marked erythropoiesis in the liver and spleen. The erythroid elements in the bone marrow, liver, and spleen of the affected puppy were also more immature than those in the marrow of the normal litter mate. There was no evidence of kernicterus. The three remaining Do-positive puppies gained weight more slowly than their normal litter mates, but ultimately made complete recovery.

The observations cited are considered sufficient to establish the diagnosis of hemolytic disease of varying severity in the four puppies with erythrocytes containing a factor present in the red cells of their sire but lacking in the red cells of their mother. The four litter mates with erythrocytes lacking this factor were apparently normal. A separate paper (*3*) will describe more completely the observations on this litter and on litters born of dams immunized against other canine factors.

Abelson (*1*) has observed what appeared to be naturally occurring hemolytic disease in newborn dachshunds. It is believed, however, that the present report records the first unequivocal serologic and hematologic evidence of this disease in puppies born of a mother previously immunized by transfusions. These experiences suggest that hemolytic disease in dogs may be produced with some degree of frequency and that studies on this species may aid in clarifying certain aspects of erythroblastosis fetalis as it occurs in human beings. Opportunities for controlled observations on large litters sired by heterozygous males seem particularly attractive.

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[1] The investigations described in this paper were carried out under a contract between the University of Rochester and the Office of Naval Research and in part under contract with the U. S. Atomic Energy Commission at the University of Rochester Atomic Energy Project, Rochester, New York.

In the litter described, the pups had suckled for about two hours before the first blood samples were drawn. Do-positive pups in three subsequent litters were similarly affected, but examinations of the blood before and after suckling revealed that most, if not all, of the Do-antibody was acquired from the dams' milk.

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The Antithyroid Factor of Yellow Turnip[1]

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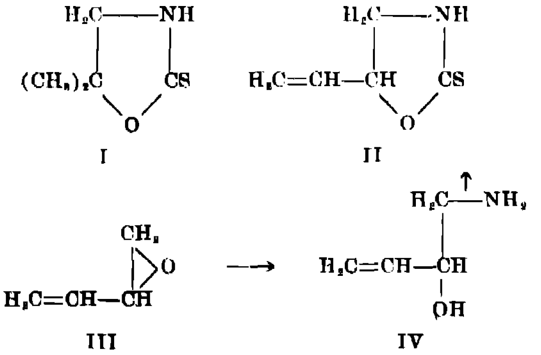
It has been well established that goiter may be induced in laboratory animals by diets of certain vegetables such as cabbage, turnip, or rape. A recent study (*2*) of the antithyroid effect of various foods in man disclosed marked activity in the yellow turnip or rutabaga, *Brassica napobrassica*. This antithyroid principle has now been isolated in crystalline form and its structure determined.

The purification of the goitrogen was controlled by antithyroid assay of crude preparations in the rat, and later by measurement of the ultraviolet absorption spectrum. The active substance was released from ground rutabaga root by extraction with cold water, and concentrated by appropriate distribution between ether and alkaline buffers. The concentrates so prepared could be crystallized directly from ether with the aid of seed crystals, which were originally obtained from material that had been further purified by distillation in high vacuum and chromatographic adsorption on alumina. The active principle was isolated in a yield of 0.2 g/kg of root as colorless crystals of formula C_5H_7ONS, mp 50°, $[\alpha]^{25}_{D}-71°$ (2% methanol solution). The same substance was obtained from the root of white turnip, and in larger quantities (1–8 g/kg) from the seeds of rutabaga, white turnip, cabbage, kale, and rape. Its antithyroid activity in man approximately equals that of 6-*n*-propylthiouracil.

Since no pure chemical degradation product could be obtained from the goitrogen, its structure was deduced largely from physical evidence. The compound in aqueous solution was found to be a weak acid (pK_a 10.5) and to have an intense ultraviolet absorption maximum at 240 mμ and log ε 4.24, which was shifted by alkali to 232 mμ, log ε 4.06. In these properties it closely resembled 5,5-dimethyl-2-thioöxazolidone (formula I), a natural product (*3*) of similar composition. Furthermore, the infrared absorption spectrum of the unknown in chloroform solution exhibited a system of bands at 2.9 μ, 3.15 μ, 6.6 μ (inflected at 6.5 μ), and 8.6 μ, which was found to be highly characteristic of 2-thioöxazolidones, and contained two bands at 10.17 μ and 10.85 μ, indicating the presence of a vinyl group (*1*). Coupled with the absence of terminal methyl groups, these facts required that the rutabaga goitrogen have the structure of a vinylthioöxazolidone. The observation that treatment of the substance with boiling 4N HCl destroyed optical activity without liberating ammonia strongly suggested the attachment of the oxygen rather than the nitrogen atom to the allylic center of asymmetry. Therefore, the antithyroid factor of rutabaga was considered to be L-5-vinyl-2-thioöxazolidone (formula II).



The assigned formula was confirmed by synthesis. Reaction of butadiene 1,2-monoxide (formula III) (*4*) with ammonia produced a mixture from which a pure aminoalcohol, in all probability 1-amino-3-buten-2-ol (formula IV), was separated as its acid oxalate, mp 131°. Conversion of this aminoalcohol to the dithiocarbamate with carbon disulfide and alkali, followed by cyclization with lead nitrate, furnished DL-5-vinyl-2-thioöxazolidone, mp 63°, which had the same infrared spectrum as the rutabaga factor. L-1-Amino-3-buten-2-ol, obtained by resolution of the racemic aminoalcohol with D-α-bromocamphor-π-sulfuric acid, was similarly transformed into synthetic L-5-vinyl-2-thioöxazolidone, identical with the natural product.

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Properties of Barium Titanate in Connection with Its Crystal Structure

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In recent years the uncommon properties of barium titanate ($BaTiO_3$) and some related compounds have attracted much attention. In rapid succession more than 70 publications of various lengths have already appeared, and the subject has been given even more notice since it has become possible to obtain clear crystals from different melts (*1*). In the present paper we will discuss how the abnormal behavior of these dielectric materials is closely related to the structure of the crystal lattice.

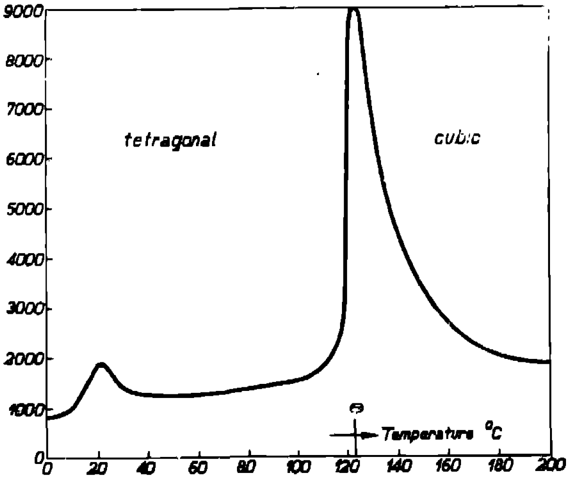

FIG. 1. Dielectric constant of barium titanate measured at low field strengths as a function of temperature.

First we give a general survey of the well-known properties of $BaTiO_3$, the influence of the temperature T and the field strength E on the dielectric constant ε. Fig. 1 shows the relation between ε and T, when measured in a weak a-c field at a frequency between 1 kc and 10 mcps. There is one very high peak in ε at $T = 123°$ C and two small ones at $T = 12°$ C and $T = -70°$ C. The temperature of 123° C (θ) divides this graph into two temperature regions where $BaTiO_3$ shows quite different properties. At temperatures above θ the polarization is a linear function of the electric field strength, the dielectric losses are low, and the only remarkable thing is the steep fall of ε with rising T. The dependence of ε on T in this region is given by a very simple relation:

$$\varepsilon = \frac{A}{T - \theta},$$

A being a constant, approximately equal to the reciprocal value of β, the linear coefficient of thermal expansion.

For $BaTiO_3$ we find experimentally

$$\varepsilon = \frac{102{,}000}{T - 396} \text{ and } \beta = 0.05 \cdot 10^{-4}.$$

In the temperature region below θ the properties are completely changed. ε is no longer a constant, but becomes dependent on the electric field strength. The electric polarization can be considered as composed of two parts: a linear part caused by electronic and ionic displacements, and a nonlinear part which can be saturated at high field strength and which consists of dipole orientation (Fig. 2). The nonlinear part gives only a small contribution to the polarization at low field strengths; at higher field strengths, however, the contribution of this part gradually develops until saturation is reached. The final slope of the hysteresis loop is approximately equal to the initial slope of the initial curve. The dipole contribution causes hysteresis and remanence of polarization, just as in the case of a ferromagnetic material.

The temperature of the peak of ε can be largely influenced by preparing mixed crystals with some other titanates, stannates, and zirconates. Only in the case of mixtures with $PbTiO_3$ do we find an increase of θ, all other additions reducing the value of θ. Solid solutions of these materials are possible, as they all have the same crystal structure, the so-called perovskite structure (perovskite is the mineral $CaTiO_3$). Fig. 3 gives a general picture of the crystal lattice, with a Ti-ion in the center, O-ions at the centers of the faces, and Ba-ions at the corners. In general this is a cubic lattice, but Goldschmidt (*2*) has already shown that there are only few really cubic perovskites. The possibility that three different types of ions will fit in a parameterless cubic structure is not large. Strontium titanate is an example. The unit cell of $BaTiO_3$ shows a slight tetragonal deformation at temperatures up to θ. At this temperature a transition to the cubic form takes place. In the following sections we will discuss the relation between the crystal structure and the electric properties in the different temperature regions.

The high temperature region. Let us consider $BaTiO_3$

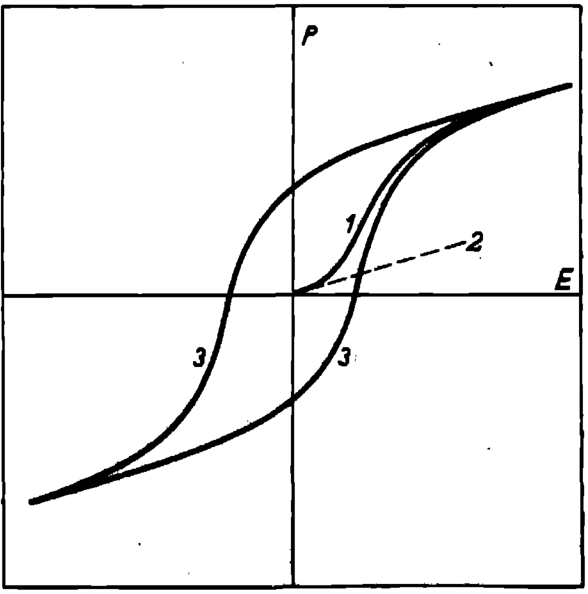

FIG. 2. Electric polarization (P) as a function of field strength (E): 1—initial curve, 2—initial slope of initial curve, and 3—hysteresis loop.

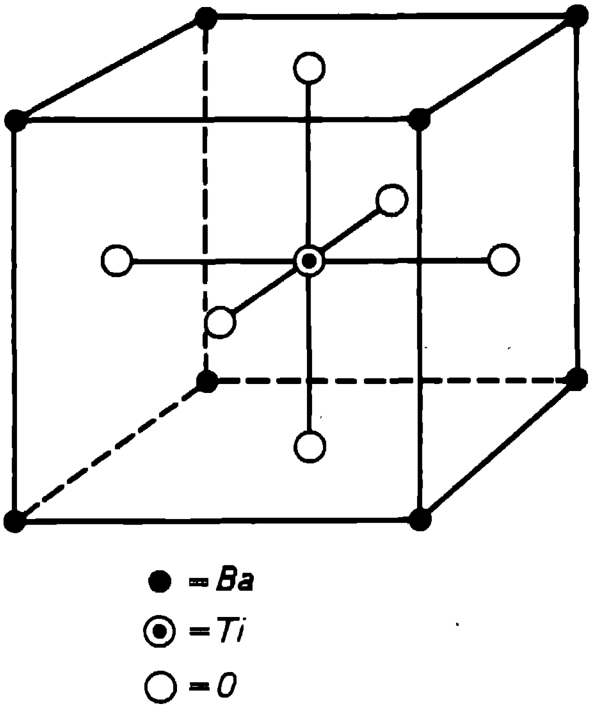

FIG. 3. Unit cell of barium titanate.

above its transition temperature. In this temperature region the substance behaves like a "normal" dielectric, except that the dielectric constant is exceptionally high and strongly dependent on temperature. Before discussing these properties we shall examine more closely the formulas giving the relation between the macroscopic dielectric constant and the properties of the component ions (or atoms).

The well-known formulas of Lorentz-Lorenz and Clausius-Mosotti become for $BaTiO_3$

$$\frac{n^2-1}{n^2+2} = \frac{4\pi}{3} N\alpha^{(e)} = \frac{4\pi}{3} N \left\{ \alpha_{Ba}{}^{(e)} + \alpha_{Ti}{}^{(e)} + 3\alpha_O{}^{(e)} \right\} \qquad (1)$$

and

$$\frac{\varepsilon-1}{\varepsilon+2} = \frac{4\pi}{3} N \left\{ \alpha^{(e)} + \alpha^{(i)} \right\}$$
$$= \frac{4\pi}{3} N \left\{ \alpha_{Ba}{}^{(e)} + \alpha_{Ti}{}^{(e)} + 3\alpha_O{}^{(e)} + \alpha^{(i)} \right\}. \qquad (2)$$

Here n denotes the index of refraction; N is the number of unit cells per cm^3; $\alpha_{Ba}{}^{(e)}$, $\alpha_{Ti}{}^{(e)}$, $\alpha_O{}^{(e)}$ are the optical polarizabilities of Ba, Ti and O ions respectively; α^i is the contribution of ionic displacement polarization.

One of the assumptions underlying eqs (1) and (2) is that the environment of every polarizable particle displays cubic symmetry, the local polarizing field then being for each particle:

$$E^{(loc)} = E + \frac{4\pi}{3} P$$

(E = electric field strength, P = polarization).

For crystals for which this symmetry condition is not fulfilled, the Lorentz-Lorenz and Clausius-Mosotti formulas must be corrected and this can be done by adding to the polarizability (*9, 10*) a correction term which depends on the geometrical structure of the lattice and on the polarizabilities of the ions.

In the case of $BaTiO_3$ (see Fig. 3) some ions surround each other in a cubic way while others do not. For example a Ba-ion is surrounded cubically by Ba-ions (its six nearest neighbors are placed at the corners of a regular octahedron) and by Ti-ions (the eight neighbors forming a cube). For oxygen ions, however, the microscopic symmetry is not cubic (its six nearest neighbors are two Ti- and four Ba-ions). Thus for $BaTiO_3$ in eqs (1) and (2), a correction term must be added to the expression between parentheses, but we shall not use it here. In eq (1) the correction proves to be negligible.

When we try to understand the high value of the dielectric constant of $BaTiO_3$ in its cubic temperature region there appear to be at least three contributing factors. First of all $BaTiO_3$ possesses a high refractive index, namely 2.4^5; thus in eqs (1) and (2): $\frac{4\pi}{3} N\alpha^{(e)} = 0.63$, a rather high value. It is easily seen from eqs (1) and (2) that now a relatively small ionic polarization can give rise to a high dielectric constant. The cause of the high index of refraction is the compactness of the $BaTiO_3$ lattice (the Ba- and O-ions form together a close-packed cubic structure, the Ti-ions being placed in the octahedral interstices) combined with the high optical polarizability of the O- and Ba-ions. In this connection we would remark that in general the optical polarizability of oxygen ions near small, high charge positive ions appears to be much smaller than near large, low charge ions. In the case of oxygen ions next to (tetravalent) Ti-ions, however, this lowering of the polarizability of oxygen does not seem to take place. This high optical polarizability is found in many compounds containing Ti surrounded by six O-ions (TiO_2 in its modifications rutile [$n_\omega(D) = 2.62$, $n_\varepsilon(D) = 2.90$], anatase [$n_\omega(D) = 2.56$, $n_\varepsilon(D) = 2.49$] and brookite [$n_\alpha(D) = 2.59$, $n_\beta(D) = 2.59$, $n_\gamma(D) = 2.70$]; titanates with perovskite structure [$CaTiO_3$ $n = 2.38$; $BaTiO_3$ $n = 2.4^5$]; pyrophanite, $MnTiO_3$ showing ilmenite structure [$n_\omega(D) = 2.48$, $n_\varepsilon(D) = 2.21$]).

In the second place a high dielectric constant for $BaTiO_3$ is favored by a large contribution from the Ti-ion to the ionic-displacement polarization. Goldschmidt (*2*) has remarked that the perovskite structure ABO_3 would be stable only if the parameter

$$t = \frac{r_A + r_O}{(r_B + r_O)\sqrt{2}}$$

were approximately unity (*6*). This is easily seen from Fig. 3. For $t < 1$ or $t > 1$ the ions A (e.g. Ba) or B (e.g. Ti) respectively have a relatively large space to move in; too large deviations of t from unity give rise to other structures. It appears that of all titanates, thorates, zirconates, cerates, and stannates, $BaTiO_3$ and $PbTiO_3$ occupy a singular position, since the Ti-ion can move rather easily between its six nearest oxygen neighbors. This means that at the Ti-place a considerable ionic-displacement polarizability is localized, contributing to the term $\alpha^{(i)}$ in eq (2).

A third circumstance favoring a high value of the dielectric constant is the particular structure of the perovskites. It appears that the correction term that has to be added to the righthand side of eq (2) because of the insufficiently high symmetry of the perovskite lattice becomes considerable if at the place of the Ti-ion a polarizability is localized. Thus the "loosely bound" Ti-ion not only gives its "normal" contribution to $\alpha^{(i)}$ but also gives rise to a correction term, α_{cor}, which cannot be neglected.

If we accept the given interpretation of the high dielectric constant of $BaTiO_3$, we can easily show that a strong dependency on temperature is to be expected (*7*). In order to explain this dependency, the occurrence of permanent dipoles in the high temperature region has been assumed by some authors. We think, however, that such an assumption should not be made since the following simple argument can give a quantitative explanation.

Writing eq (2) with the correction term α_{cor} included as

$$\frac{\varepsilon - 1}{\varepsilon + 2} = \frac{4\pi}{3} N\alpha, \tag{3}$$

where α stands for $\alpha^{(e)} + \alpha^{(i)} + \alpha_{cor}$, we find for the temperature coefficient

$$\frac{1}{\varepsilon}\frac{\partial\varepsilon}{\partial T} = \frac{(\varepsilon - 1)(\varepsilon + 2)}{3\varepsilon}\left\{\frac{1}{N}\frac{\partial N}{\partial T} + \frac{1}{\alpha}\frac{\partial\alpha}{\partial T}\right\}. \tag{4}$$

Putting $\frac{1}{N}\frac{\partial N}{\partial T} = -3\beta$ (β = coefficient of linear expansion) and approximating $\varepsilon - 1$ and $\varepsilon + 2$ by ε, we obtain from eq (4):

$$\frac{1}{\varepsilon}\frac{\partial\varepsilon}{\partial T} = \varepsilon\left\{-\beta + \frac{1}{3}\frac{1}{\alpha}\frac{\partial\alpha}{\partial T}\right\}, \tag{5}$$

$$\text{or } \varepsilon = \frac{1}{\left(\left(\beta - \frac{1}{3}\frac{1}{\alpha}\frac{\partial\alpha}{\partial T}\right)(T - T_0)\right)}, \tag{6}$$

where T_0 is an integration constant.

We have already seen that experiments above the transition temperature θ can be described by

$$\varepsilon = \frac{1}{\beta(T - \theta)} \tag{7}$$

From this it follows that

$$\frac{\partial\alpha}{\partial T} = 0, \tag{8}$$

and

$$T_0 = \theta. \tag{9}$$

The value of θ can be expressed in terms of the dielectric constant ε' measured at a temperature T' by

$$\theta = T' - \frac{1}{\beta(\varepsilon' + 2)} \tag{10}$$

It is to be noted that to eq (7) a factor must be added in order to correct for the porosity of the titanate samples. If we call ε_{exp} the measured value of the dielectric constant of a sample with a small amount p of spherical holes, eq (7) becomes

$$\varepsilon_{exp} = \frac{1 - \frac{3}{2}p}{\beta(T - \theta)}. \tag{7'}$$

As to eq (8), one might think that this equation is rather trivial. It is necessary, however, to discuss separately the temperature dependency of all three contributions to $\alpha = \alpha^{(e)} + \alpha^{(i)} + \alpha_{cor}$. It is well known that $\alpha^{(i)}$ increases with increasing temperature, since the restoring forces playing a part in the infrared vibrations of the lattice decrease owing to the thermal expansion of the crystal.

It can be expected that $\alpha^{(e)}$ also depends on temperature since we have found that for many simple ionic compounds like NaCl $\alpha^{(e)}$ shows a positive temperature coefficient (*8*).

It is difficult to predict the temperature dependency of α_{cor}. From eq (8) we can infer that $\frac{\partial\alpha_{cor}}{\partial T}$ cancels the effects of $\frac{\partial\alpha^{(e)}}{\partial T}$ and $\frac{\partial\alpha^{(i)}}{\partial T}$.

It is interesting to notice the analogy between

$$\chi_{el} = \frac{\varepsilon - 1}{4\pi} \approx \frac{\varepsilon}{4\pi} = \frac{1}{4\pi\beta(T - \theta)}, \tag{11}$$

where χ_{el} denotes the electric susceptibility, and Curie-Weiss's law for paramagnetics

$$\chi_{magn} = \frac{C}{T - \theta_m}. \tag{12}$$

(χ_{magn} = magnetic susceptibility, θ_m = Curie temperature).

It must be emphasized, however, that the similarity is only a *formal* one. In the electric case χ_{el} increases with decreasing T, since the number of polarizable particles per unit of volume increases (thermal contraction effect); in the magnetic case χ_{magn} increases with decreasing T, since the permanent magnetic moments can be more easily oriented (Boltzmann-factor effect).

All these considerations about polarizabilities and temperature-dependencies hold equally for mixed crystals of $BaTiO_3$ with other perovskites. Eq (10) enables us to explain the variation of the peak temperature θ with the composition of the mixed crystals. By substitution, by means of the corrected Clausius-Mosotti formula, we find

$$\theta = T' - \frac{1}{3\beta} + \frac{4\pi}{9\beta} N'\alpha', \tag{10'}$$

where N' and α' are the values of N and α at the temperature T'.

Since all the variables in this formula show only a small and (to a first approximation) linear dependency on the composition, we see at once that θ also varies linearly (Fig. 4). The variations of the product $N'\alpha'$ when replacing Ba by Sr are only small; because of the factor $\frac{1}{\beta}$, however, large effects on θ result.

The low temperature region. Let us consider a titanate dielectric below its transition point, and thus in the temperature region where spontaneous polarization occurs. In view of crystallographic considerations it is reasonable to ascribe this polarization mainly to a displacement of the Ti-ions from the centers of their octahedral interstices. Such an eccentric Ti-ion acts on its environment as if a Ti-ion were placed in the center, together with a dipole of moment equal to ionic charge × displacement. It is interesting to examine the interaction of such dipoles more closely. The Ti-ions are placed at the points of a simple cubic lattice; thus it is evident that the state of lowest energy should be a macroscopically unpolarized arrangement where alternating strings of dipoles occur, rather than a polarized arrangement where all dipoles are pointing in the same

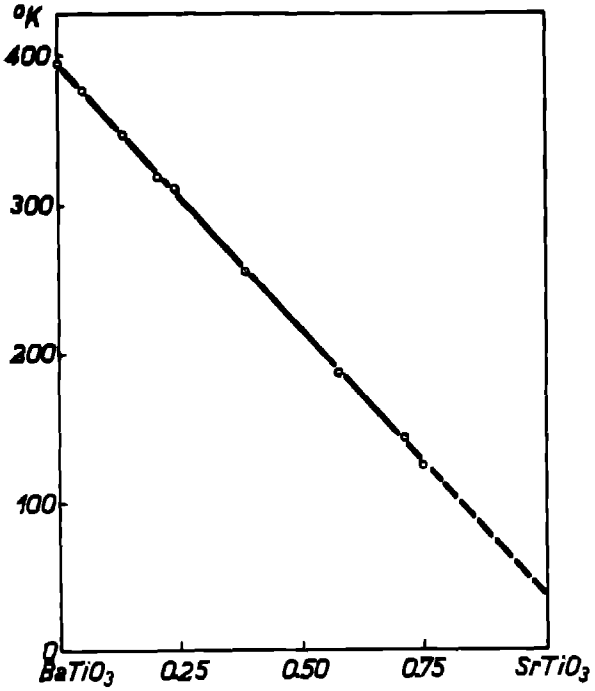

FIG. 4. Transition points of mixed crystals of barium and strontium titanate.

direction (*5*). It is possible, however, to understand why in the perovskite lattice the polarized state is favored. Let us consider a cross section through the lattice (Fig. 5). All Ti-ions are separated by easily polarizable O-ions, in which dipole moments can be induced by the Ti-dipoles. It is easily seen that a parallel orientation of a row of Ti-dipoles is favored by the oxygen ions *A*, which assume induced moments in the same direction. Such rows of parallel Ti-dipoles are coupled together by oxygen ions *B*, the moments in these oxygen ions pointing in the opposite direction. For other positions of the oxygen ions *B* such a coupling would not occur.[1] The particular properties of the perovskite structure making the spontaneous polarization possible also give rise to a favorable deviation from the formula of Clausius-Mosotti in the temperature region above θ. The infrared vibrations corresponding to tetragonal deformation have a small restoring force and give a large contribution to the ionic polarizability and thus to ε.

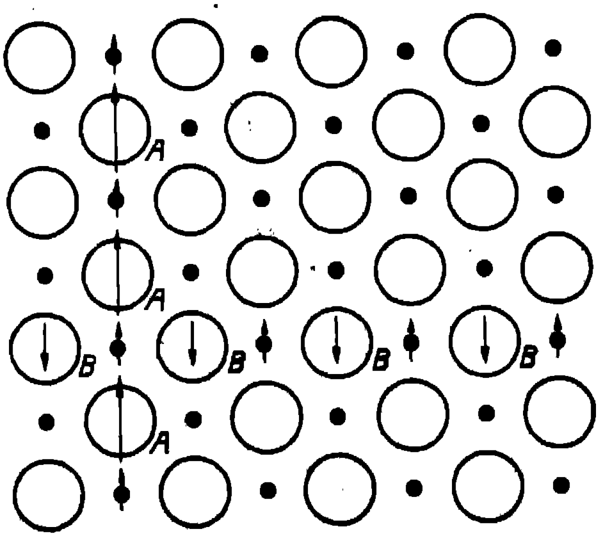

FIG. 5. Cross-section through the barium titanate lattice.

The transition temperature. Coming from high temperatures, the cubic form of $BaTiO_3$ becomes at a certain temperature unstable with respect to the polarized tetragonal form (*3*) (probably a first-order transition). There are two approaches to describing this transition, coming from the high and from the low temperature region.

In the first place it is to be noted that the restoring force just mentioned contains, besides positive contributions (e.g., the Born repulsion), negative contributions arising from the polarization of the lattice during the vibration. In view of the close relation between this polarization and ε, the negative contribution to the restoring force becomes increasingly important as ε increases by the contraction of the lattice, so that at a certain temperature the negative prevails over the positive contribution, and as the corresponding frequency approaches zero, a spontaneous deformation of the lattice occurs. At the same moment the dipoles, which play such an important role in the low temperature region, are formed by a shift of the titanium ions in the direction of the elongated *c*-axis.

On the other hand, we can start from the spontaneously polarized state. In the section on the low temperature region it was made plausible that the interaction between the Ti-dipoles takes place through the medium of the oxygen ions between them. Such an interaction must decrease as the lattice expands, so that at a certain temperature the energy of interaction becomes of the order of kT and the spontaneous polarization is destroyed.

It is difficult at the moment, however, to treat these problems quantitatively, since data concerning internal forces are rather scarce and particularly because the ionic picture used is only a zero-order approximation.

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[1] In the structure of the hexagonal form of $BaTiO_3$ proposed by Evans and Burbank (*1*), which shows a low dielectric constant, such an effect cannot occur, the rows of Ti-ions being interrupted.

Comments and Communications

Late Pleistocene Dates Derived from Radiocarbon Assays

Current research on natural radiocarbon (LIBBY, W. F., *et al. Science*, 1949, 109, 227) presents an opportunity to learn the actual dates of origin of carbon-bearing material less than about 35,000 years old. Such material includes, among other substances, buried soils, wood, charcoal, bone, and calcareous shells.

If adequate amounts of this material are collected from horizons of accurately known stratigraphic position and are assayed, the dates of these horizons (if less than about 35,000 years old) can be determined. The importance of such dating for establishing the chronology of the later part of the Wisconsin age of the Pleistocene epoch is obvious.

In particular, if the Mankato drift can be dated by this method, rough dates can be obtained for earlier Pleistocene glacial stages. Kay's estimates of the dates of earlier Pleistocene drift sheets were obtained by comparing the depth of chemical decomposition of each of these drifts with the decomposition of the Mankato drift, for which an age of 25,000 years was assumed (cf. FLINT, *Glacial geology and the Pleistocene epoch*, 1947, p. 399). The application of radiocarbon assay to the Mankato drift should improve Kay's estimates materially.

This research on natural radiocarbon is being conducted at the Institute for Nuclear Studies, University of Chicago, under the direction of W. F. Libby. Assays of carbon-bearing material can be made there promptly, if the material has great enough stratigraphic importance.

For the present, material for assay is being selected in collaboration with the Committee on Radioactive Carbon 14, appointed by the American Anthropological Association, under the chairmanship of Frederick Johnson. The writer is serving on the Committee as member for geology. A number of projects, involving dates that are especially desired, have been set up. Those having primary significance for anthropology are named Early Man, Peru, Central and Northern Mexico, Mesopotamia and Western Asia, Scandinavia and Western Europe, Yukon-Alaska, California-Oregon, Hopewell-Adena, and Southeastern United States. In some of these projects the dating of archaeological material will also have direct significance for Pleistocene geology.

Geologic material suitable for assay is less abundant and less intensively collected than archaeological material. The committee believes, however, that when geologists having access to such material are acquainted with the general problem and with sampling requirements in particular, they will very quickly supply samples of geological importance.

Geologists working on late-Pleistocene stratigraphy are therefore urged to look for material suitable for assay. The requirements at present are as follows:

1. The minimum quantity of wood for assay is 1½ lb (dry weight). The minimum for shells is 4 lb because of their smaller content of carbon.
2. An exact description of the locality and of the stratigraphic horizon from which the collection is made should be sent with the material, and the basis of stratigraphic dating of the horizon should be stated. Detailed photographs would also be helpful.
3. Evidence that the material is indigenous to the horizon from which it was collected, rather than having been derived from some older horizon, is important.
4. Materials derived from two different horizons, each of known stratigraphic date superposed in vertical sequence, are especially desired for the purpose of checking the accuracy of assay.
5. Two or more pieces of material composed of different substances (e.g., wood and bone), collected at different points in a single horizon of known stratigraphic date, are also especially desired for assay checking.

Any geologist possessing or having access to material that meets these requirements is urged to send the writer a full description of it. Please do not send the material.

RICHARD FOSTER FLINT
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A Note on Inexpensive One-Way Vision Material

Many psychologists are interested in effective but inexpensive means of assuring one-way vision for observation. The new commercial one-way vision mirror glass is far more effective and less streaky than earlier half-silvered mirrors, but remains very expensive. White painted screening, while cheap, is not totally effective in barring vision into the observation room or booth.

Some time ago the use of colored cellophane for this purpose was suggested (PRATT, J. G., *Amer. J. Psychol.*, 1937, 49, 309). While this note was in press a similar one was described: (GRUMMON, D. L. *Amer. Psychologist*, 1949, 4, 114). However, in our experience, when enough layers of cellophane were used to bar vision in the wrong direction vision out of the booth tended to be obscured to an undesirable degree. For several years now, we have successfully used uncolored, silvered cellophane for one-way vision material.[1] In our use, the material is placed on the observation room side of a double plate-glass window opening on a brightly lighted experimental room. The cellophane is held in place with strips of scotch tape, so that the observation room may be converted rapidly to a camera booth for filming through the window.

LAWRENCE JOSEPH STONE
Department of Child Study, Vassar College

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[1] We have obtained this material under the trade name "Hy-Siltone" in 50-ft rolls, 20-in. wide, for $2.50 from the Hy-Sil Manufacturing Company, Revere, Mass.

Book Reviews

George Ellett Coghill: naturalist and philosopher. C. Judson Herrick. Chicago: Univ. Chicago Press, 1949. Pp. xi + 280. $5.00.

In the small book which first made Coghill internationally known, *Anatomy and the problem of behaviour* (Cambridge, Engl.: 1929), Coghill wrote in the preface that in Judson Herrick "I have enjoyed these many years a constant influence of orientation and stimulation in neurological work." The living friendship between the two men lasted almost half a century. In the nature of their special scientific work, and in the breadth of their scientific and philosophical interests, Herrick and Coghill not only were very similar, but helped each other to arrive at this similarity. Nothing, then, could be more appropriate than that Herrick should write the story of Coghill's life and work and its significance.

It may at once be said that this is an extraordinarily good book. It should be read by the whole scientific confraternity, especially by those younger men who are about to enter its not untroubled domain. And if only the lay public could be persuaded to read this book, about the life, work, and vicissitudes of a great representative American man of science, it would be much to the advantage of society in general and to the scientist in particular.

Herrick makes the story of the life of science as lived by Coghill, the development of his science, and the interrelationship of the two themes, the vehicle for a most cogently expressed plea for the humanization of science. "My thesis," writes Herrick in his preface, "is this: The traditional code of science—that is, the objectives sought and the methods of investigation—cannot satisfy the requirements of our critical times, and this is why science has failed to measure up to the opportunities and obligations before it. The generally accepted ideas of what natural science is and what it is for are out of date and need radical revision. We have been taught for centuries that pure science is a system of facts and impersonal abstractions, devoid of human interest and without concern for values. It isn't, and it cannot be. The time has come to recognize the humanistic value of science—so-called pure science, I mean—and to adjust our practice accordingly."

And again, in the epilogue: "Scientific facts are not worth what it costs to discover them unless they can be so interpreted as to lead to value-judgments as guides to more satisfying purposeful action."

This book is one of the best proofs of this thesis.

The book is divided into three parts. The first is devoted to the life of Coghill living his science. Scientists will read this chapter with admiration, and perhaps not altogether with astonishment at the academic disaster which was so unjustly and so cruelly visited upon Coghill. The second part contains the best and most readable account of Coghill's important work and its significance that has thus far appeared. The third part is devoted to an invaluable discussion—in dialogue form—of Coghill's philosophical outlook. Five appendices are devoted to notes, a list of published works and manuscripts, supplementary biographical data, data on the killfish, and acknowledgments. There is a good index.

This is a great book on one great American man of science by another.

M. F. ASHLEY MONTAGU

Hahnemann Medical College

Science at war. J. G. Crowther and R. Whiddington. New York 16: Philosophical Library, 1948. Pp. iv + 185. (Illustrated.) $6.00.

The output of books on the late war has only begun. A large number of purely factual reports have come out, written to give the general public an idea of what went on. But the controversial books, written in an attempt to draw lessons or conclusions from the conflict, are just beginning. Blackett's *Fear, war and the bomb* is one and Fuller's *History of World War II* is another, less disagreed with than the former, though nearly as thought-provoking.

Science at war is one of the factual reports, this time about the contributions of British scientists to the war effort, particularly in radar, operations research, nuclear physics, and undersea warfare. It is a counterpart to the Little, Brown series on *Science in World War II*, which treats of the American contribution; and a comparison of the English book with the American series, particularly with J. P. Baxter's *Scientists against time*, is enlightening.

One notices that the British book is more concerned with the scientific ideas and factual content involved in the developments, whereas the American effort spends more time on questions of organization and personal aspects. Baxter's book is easier to read, but if one is persistent one will gain more understanding of the working principles of radar and of asdic, for instance, from Crowther and Whiddington. In particular, their section on radar, with its many clarifying pictures, is well worth careful reading.

Reading both books produces some confusion at first, for they are, to some extent, mutually exclusive. To read *Science at war* gives one the impression that 90 percent of the contribution was made in England, whereas Baxter's book gives the impression that 75 percent was done over here. This semichauvinism is understandable, of course, for each author's task was to report the contributions of his own country's scientists and he could not do this by spending much time on (to him) foreign developments. One only hopes that, sometime, a complete history will be written, placing all contributions in their proper relation.

Of particular interest is the section on operational research, since this aspect of science's contribution was so inadequately covered in the American series. Crowther and Whiddington give an interesting, though somewhat fragmentary, discussion of early developments, and a very clear presentation of the scope and methods of this new branch of applied science. A number of examples of the application of the methods are given, then a discussion of general principles which is adequate, though not as complete or satisfactory as the famous articles of Blackett and of Goodeve.

The discussion on the atomic bomb adds nothing beyond what is contained in the Smyth report, other than a bit more detail of the British contributors and their early activities before coming to the United States to work for the Manhattan District.

The chapter on "Science and the Sea," on the other hand, contains much on mines and minesweeping that is not to be found in American books. This is, of course, owing to the fact that our forces had very little trouble with mines, whereas the British suffered considerable loss, especially because of the magnetic mine, which they had solved and countered before our entry into the war. The discussion of submarine detection is brief, but fairly complete.

On the whole, this book is a readable and interesting volume, a useful complement to our own reviews.

PHILIP M. MORSE

Massachusetts Institute of Technology

Blood transfusion. Elmer L. DeGowin. Robert C. Hardin, and John B. Alsever. Philadelphia-London: W. B. Saunders, 1949. Pp. xii + 587. (Illustrated.) $9.00.

A valuable if expensive lesson from the recent World War was the important uses of blood, plasma, and plasma derivatives in the specific therapy of many conditions previously treated only symptomatically if at all. The very low mortality in the members of the armed forces in this war has been credited in part to the free use of these materials. When the many experienced physicians returned from military service to civilian practice, they demanded more blood and blood fractions for everyday surgery, emergency medicine, and replacement therapy. This has lead to a considerable increase in blood banks and a great demand for many more.

To answer the many questions which the physician asks regarding blood transfusion, there has been an unusual paucity of authoritative and up-to-date text books. The appearance of *Blood transfusion* by DeGowin, Hardin and Alsever can justifiably be acclaimed as the answer to many a physician's prayer and a standard source of information which should help the everyday practitioner, the beginner in blood bank work, and the experienced director of such an operation who encounters problems of management.

It is well to know the authoritative background for this book. Elmer L. DeGowin has been, for almost ten years, the director of a large blood transfusion service and has served as a member of the important Committee on Blood and Blood Derivatives of the National Research Council. Robert C. Hardin was senior consultant in blood transfusion in the European Theatre of Operations and in charge of the European Theatre of Operations Blood Bank in Paris. John B. Alsever had considerable experience as director of the Blood Plasma and Blood Donor Services for the Office of Civilian Defense and the American National Red Cross during the war.

Such a wealth of personal experience cannot help but yield valuable information on blood transfusion, blood bank management, and allied problems. In addition, the authors have reviewed the literature comprehensively and bring a widely scattered bibliography up to date.

If any criticism of this much-needed text is possible, it is that recent advances in this field are continuing so rapidly that already new techniques and new therapeutic possibilities not described here are being exploited. The chapter on the use of blood derivatives, one of the most challenging advances in medicine, is too brief in view of these recognized future possibilities.

It is hoped that this volume will be as widely read as it needs and deserves to be and that new editions will keep the book in its present position of absolute leadership in this field.

LOUIS K. DIAMOND

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Contribution a l'Etude de la Structure Moléculaire. (Volume Commemoratif Victor Henri.) With prefaces by L. Brillouin and J. Duchesne. Liège, Belgium: Maison Desoer, 1947–1948. Pp. xiii + 314. (Illustrated.)

Victor Henri will long be remembered for his significant contribution to the experimental work in molecular spectroscopy. His death, while he was working as a physicist in the service of his country, came at a time when there was little time to pause and pay respect to his memory. His former students and colleagues resolved, however, when times again became more normal, to memorialize his contribution with a volume of works in the field where he had served as so great a stimulation. This volume of papers is entitled *Contribution to the study of molecular structure* and contains 26 contributions by 36 authors, in addition to two prefaces by L. Brillouin and J. Duchesne.

It is not possible in a review of this nature to comment critically on a compilation of so great a diversity. One cannot avoid, however, observing that the list of authors is studded with stars from the field of molecular structure and molecular spectroscopy. Some of the authors are physicists, some are chemists; some are experimenters and some are theoretical scientists; but all are well known in an international sense.

The volume represents a compilation that every student of the structure of molecules will want to possess and will want to refer to again and again in his more creative work for many years to come. It should, therefore, admirably serve its purpose, namely, to keep the name of Victor Henri alive among the men who serve where he left off.

HARALD H. NIELSEN

Mendenhall Laboratory of Physics,
Ohio State University

NEWS and Notes

Karl T. Compton has been elected director of the McGraw-Hill Publishing Company. Dr. Compton is chairman of the Research and Development Board of the National Military Establishment and chairman of the Corporation of the Massachusetts Institute of Technology.

H. B. Mann, professor of mathematics at Ohio State University, has been appointed visiting professor at the University of California for the academic year 1949–50. Dr. Mann, who recently took several months' leave to head a project at the Applied Mathematics Laboratories of the National Bureau of Standards, has returned to Ohio for the summer quarter.

Allen Goodrich Shenstone, of Princeton University, has been appointed acting chairman of the Department of Physics in the absence of Henry de Wolf Smyth, who is on leave as a member of the Atomic Energy Commission.

Albert Claude, associate member of the Rockefeller Institute, has been appointed professor at the University of Brussels, and director of the Institut Jules Bordet.

Nelson Marshall, director of the Virginia Fisheries Laboratory, has been appointed dean of the College of William and Mary. He will continue to serve in the laboratory, which is an associated organization of the college.

Wallace R. Brode, associate director of the National Bureau of Standards, has been appointed a member of the Board of Governors of the American Institute of Physics to replace the late **A. H. Pfund** of Johns Hopkins University. Dr. Brode will represent the Optical Society of America; he is a member of the Society's Board of Directors and associate editor of its journal.

Julius S. Youngner, formerly of the National Cancer Institute has been appointed assistant research professor of bacteriology at the University of Pittsburgh's School of Medicine.

John C. Warner, head of the chemistry department of the Carnegie Institute of Technology, has been named president-elect to succeed **Robert E. Doherty**, who will retire on July 1.

Visitors

Recent visitors at the National Bureau of Standards were: **Hadji Argyris**, head of the aircraft structures research group of the Royal Aeronautical Society of Great Britain; **G. McAlpine**, engineer with Kelvin Bottomley and Baird, of England; **A. Strasheim**, head of the Spectrochemical Section, National Physical Laboratory, Union of South Africa; **André Houpeurt**, chief of the Production Laboratory, French Institute of Petroleum, Paris; **Edy Velander**, director of the Royal Swedish Academy of Engineering Sciences, Stockholm.

N. Kurti, physicist of Oxford University, England, will take part in the Symposium on Modern Physics to be held at Oak Ridge, August 22–September 2.

Grants and Awards

The Charles Goodyear Medal for outstanding achievement in rubber chemistry was awarded to Harry L. Fisher, director of organic research of U. S. Industrial Chemicals, Inc., at the May 24 meeting of the American Chemical Society's Rubber Division, in Boston.

The first **Lester N. Hofheimer Research Award** of fifteen hundred dollars was given to Benjamin Pasamanick, head of the Children's Service, Division of Psychiatry, Kings County Hospital, Brooklyn, New York, at the recent convention of the American Psychiatric Association. The award is offered to the psychiatrist under 40 years of age who has published the best research in the preceding three years. Dr. Hofheimer's paper "A Comparative Study of Behavioral Development of Negro Infants" appeared in the *Journal of Genetic Psychology*, 1946, Vol. 69.

Ward Harrison, retired director of the Engineering Division of General Electric Lamp Department, has been awarded the 1949 **I. E. S. Gold Medal** by the Illuminating Engineering Society for his contributions to all phases of illumination development. The award will be presented at the I. E. S. National Technical Conference to be held at French Lick, Indiana during the week of September 19.

H. Trendley Dean, director of the National Institute of Dental Research, will receive the **Gorgas Award** for outstanding contributions in the field of military medicine. It will be presented November 11 at the annual banquet of the Association of Military Surgeons of the United States, which selected Dr. Dean for the award.

Recipients of the first **Medical Library Association scholarships**, from funds granted by the Rockefeller Foundation are: Lydia Pazos Pérez, assistant to the director of the Library of the Faculty of Medicine, University of Havana; María Alicia Izquierdo Guzman, assistant in the Library of the Faculty of Medicine, University of Chile; and María José Lessa da Fonseca, librarian of the Faculty of Medicine, University of São Paulo, Brazil.

Fifteen winners of the 1949 **Indiana Science Talent Search** were given memberships in the AAAS by Walter Leckrone, editor of the *Indianapolis Times*. The awards were presented by the chairman of the Talent Search Committee, R. W. Lefler, Department of Physics, Purdue University.

Alfred P. Sloan, Jr., has given one million dollars to the **Massachusetts Institute of Technology** for its new metals-processing laboratory. The laboratory is to be named for Mr. Sloan.

Eli Lilly and Company of Indianapolis has awarded nine thousand dollars to John C. Krantz, Jr., professor of pharmacology, University of Maryland School of Medicine, for research on the action of drugs useful in the treatment of hypertension and cardiovascular diseases.

Howard E. Fritz, vice president of the B. F. Goodrich Company in charge of research, was named 1949 winner of the **Lamme Medal of Ohio State University,** on June 10. Dr. Fritz was cited for his development of Koroseal and rubber products for use in chemical engineering industries.

Colleges and Universities

Rhode Island State College, with the cooperation of the Woods Hole Oceanographic Institution, has established a graduate student training program in biological oceanography and marine fisheries biology. Instruction and supervision of research will be provided by members of the staffs of the two institutions, with emphasis placed on open ocean investigation. Arrangements are being made for a limited number of students who will enroll as candidates for the M.S. degree in marine biology. The first year will be spent in Kingston and at the Narragansett Marine Laboratory; the second year at Woods Hole. Those qualified for basic oceanographic research will occupy quarters provided for them in the Woods Hole Oceanographic Institution, and those preparing for a career in applied fisheries biology may be assigned to the U. S. Fish and Wildlife station. The program is under the general supervision of Charles J. Fish and applications should be addressed to the Director of Admissions, Rhode Island State College, Kingston, R. I. Candidates for this curriculum may also make application for a fellowship. There are five available at the rate of $1,500 per year.

Meetings and Elections

Computers. More than two hundred people assembled at Oak Ridge last April to attend a meeting of the Association for Computing Machinery. The program was devoted primarily to an assessment and evaluation of large scale computing machinery as a scientific tool, and to discussions of the hazards that beset the unwary user. But there were side attractions too, such as a visit to the American Museum of Atomic Energy, now permanently installed in Oak Ridge, and a demonstration of the IBM Corporation's new model 604 multiplier.

The demand for high speed automatic machinery becomes increasingly great in all phases of science and technology, nuclear science along with the rest. In atomic energy laboratories, IBM installations are standard equipment for scientific computing. Considerable use is being made of the ENIAC, the SSEC, and Harvard's Mark I, and some of the improved versions now under development will no doubt be acquired. This was the motivation for holding the meeting in one of the principal centers of atomic research. There were, however, other organizations interested in the use or development of these machines represented on the program and among the attendance.

The National Bureau of Standards had the largest representation on the program with a total of six papers. Some papers dealt with computational techniques for large scale calculations and the special difficulties that arise therein and some dealt with problems of design. At least five of the papers represented work done, in whole or in part, for the armed forces, not to mention the banquet speech by Nina Rees, of the Office of Naval Research, on "The Forgotten Man of Computing." A brief report on developments in Australia was given by T. G. Room, of the University of Sydney.

Besides the classical problems of solving complicated equations and systems of equations, two more recent computational techniques were discussed. One is an application of the theory of games; the other is the use of stochastic methods, or what is now called the Monte Carlo Technique. Of these, the former has importance for the military, the latter is much used in atomic energy research. Both are distinctly techniques for large scale computing.

Although most of the program was devoted to digital machines, two papers dealt with machines of the analogy type. One was by S. H. Caldwell, on the differential analyzer; the other by Ray Pepinsky, whose machine for use in crystal analysis has received much acclaim since its recent completion.

Special efforts were made by the Oak Ridge Institute of Nuclear Studies, one of the sponsors of the meetings, to bring out interested research workers from the academic institutions of the Southeast. This was thought desirable because as more machines become available their use in academic research will spread.

Besides the Institute, the other sponsors of the meetings were Oak Ridge National Laboratory, Carbide and Carbon Chemicals Corporation, and Fairchild Corporation, NEPA Division.

A. S. HOUSEHOLDER

A symposium on modern physics will be held at Oak Ridge August 22–September 2, under the sponsorship of the Oak Ridge National Laboratory and the Oak Ridge Institute of Nuclear Studies. The 32 lectures to be given will include such topics as the current status of meson theory, the new quantum electrodynamics recent progress in low temperature physics, declassified nuclear reactor theory, and classical nuclear physics. The lecture staff will be composed of physicists who are spending the summer at the laboratory—among them S. M. Dancoff, University of Illinois; J. C. Daunt, Ohio State University; Eugene Feenberg, Washington University; Hubert M. James, University of Illinois; and Alvin M. Weinberg, Oak Ridge National Laboratory.

The American Mathematical Society will hold its 55th summer meeting at the University of Colorado, Boulder, August, 30–September 2, in conjunction with the summer meetings of the **Econometric Society,** the **Institute of Mathematical Statistics,** and the **Mathematical Association of America.** The 31st colloquium, on topological dynamics, will be presented by G. A. Hedlund, of Yale University.

The Second International Biometric Conference will be held at the University of Geneva in Switzerland on August 30–September 2, under the sponsorship of the Biometric Society. Aspects of biometry which will be considered in the scientific sessions include recent applications in genetics, teaching and education, experimental design, the present status of the science, industrial applications and biological assay. The conferences will close with a session of contributed papers. Further information and reservations are obtainable through the Secretary of the Conference Committee, Professor Arthur Linder, 24 Avenue de Champel, Geneva, Switzerland.

The First International Congress of Civil Engineering was held in Mexico City April 30–May 7, at the invitation of the Colégio de Ingenieros Civiles de México. Approximately 800 civil engineers were in attendance—nearly 200 from outside Mexico, with 24 countries represented. The technical program included some 175 papers dealing with all aspects of civil engineering, with particular emphasis on practice throughout the Latin American countries. Technical works visited on inspection trips during the week included the Lerma River water supply project of Mexico City, Valsequillo Dam in the State of Puebla, and the Tecamachalco Experimental Laboratory of the Department of Hydraulic Resources. Following the congress, there were trips for a number of the delegates to civil engineering works of interest at more distant points. It is planned that the Second International Congress of Civil Engineering will be held in 1953 at a location to be determined later, possibly Brazil or Puerto Rico.

Industrial Research Institute, Inc., New York City, elected the following officers at its annual meeting May 23–25: J. H. Schaefer, Ethyl Corporation, president; C. F. Rassweiler, Johns-Manville Corporation, vice president. C. G. Worthington was *reappointed secretary-treasurer.*

Lewis L. Strauss, member of the U. S. Atomic Energy Commission, was elected president of the **Corporation of the Institute for Advanced Study,** Princeton, New Jersey at its recent annual meeting. Herbert H. Maass of New York, who had been both president and chairman of the board, was reelected chairman of the board.

The Latin American Unesco Field Science Cooperation Office, following the suggestion of the Latin American Conference of Scientific Experts held in Montevideo in September, 1948, is collecting for publication biographical and technical data on scientists and scientific institutions and societies.

All Latin American scientists and scientific organizations are invited to send any possible information on their activities to Centro de Cooperación Científica para América Latina de la Unesco, Agraciada 1875, Montevideo.

The New York Zoological Society has just placed on exhibition a collection of rare birds and mammals captured by its Belgian Congo Expedition, which returned June 15. Charles and Emy Cordier, animal collectors for the society, spent over a year and a half assembling the two hundred specimens, which include a baby mountain gorilla, an okapi, Congo peacocks, black guinea fowl, giant pangolins, aardvarks, at least seven kinds of monkeys, elephant shrews, a finfoot, and sunbirds.

One of the most difficult problems facing the Cordiers on their return was that of providing a substitute diet for the animals. Giant pangolins and aardvarks feed on termites; elephant shrews subsist on a diet of grasshoppers. Mr. Cordier has accustomed these mammals to a diet including raw meat, eggs, and milk. Sweet potato leaves, customary food for the Colobus monkeys and antelopes, have been supplied to the Bronx Zoo by the A and P grocery chain.

The Australian Council for Scientific and Industrial Research, a body responsible to the federal government through a cabinet minister, has recently been reconstituted as the Commonwealth Scientific and Industrial Research Organization. The change in name is accompanied by some changes in administration, concurrently with the election of a new executive body. This body of the C.S.I.R.O. has now assumed greater responsibility, although the full council still functions in an advisory capacity to the executive. The Australian Commonwealth government announced on May 18 that the new executive would consist of the following: chairman, Ian Clunies Ross; chief executive officer, F. W. G. White; both former members of the executive of C.S.I.R. The appointments will be for seven years. They succeed respectively Sir David Rivett, F.R.S., who will however, remain associated with the new organization as chairman of the advisory council, and A. E. V. Richardson, whose ill health has necessitated his retirement. The third full time executive member will be S. H. Bastow, formerly chief of the Division of Tribophysics, C.S.I.R., appointed for five years. The fourth member will be D. A. Mountjoy whose three year term expires next November. H. J. Goodes, assistant secretary, Commonwealth Treasury, has been appointed for three years to the fifth seat on the executive.

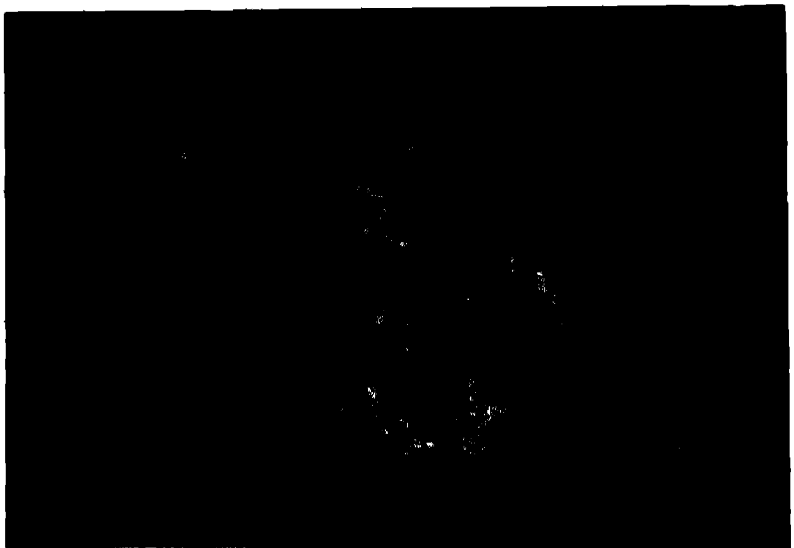
The reason for reconstitution of the council is the desire of its members, and Australian scientists generally, to avoid restrictions in carrying out fundamental scientific research devoted to the development of Australian resources and industries. During the war, responsibility for a considerable amount of both fundamental and applied research for supply departments and the armed forces devolved upon the C.S.I.R., but it is the wish of the government and of scientists in Australia that complete freedom be retained, as far as possible, for postwar research in nonmilitary matters, which are rightly the concern of C.S.I.R.O. Consequently, research work of a nature which should be restricted because of its importance to national defense is now to be carried out by the Department of Supply and Development, which has assumed the responsibility for the administration of the Division of Aeronautics (formerly a division of C.S.I.R.), Defense Research Laboratories (formerly Munitions Supply Laboratories), and the Long Range Weapons project.

A four-year survey of the sky will begin July 1 at Palomar Observatory, under the joint sponsorship of the National Geographic Society and the California Institute of Technology. The aim of the project is to provide a comprehensive sky atlas, for use primarily in selecting areas and objects for intensive study with more powerful telescopes.

Palomar's 48-inch Schmidt telescope, which will be used for the photomapping, has already been in operation for two or three years, piling up work for the observatory's new 200-inch telescope. The Schmidt's wide angle lens, which can focus on a single 14 × 14-inch plate a swathe of sky equal to a dozen diameters of our moon, will scan the sky in broad quadrangles. Identical exposures through blue and red filters will be made for each area. Palomar astronomers expect to obtain no more than four pairs of matching red and blue plates in a single night, even under ideal weather conditions. A blue exposure takes 30 minutes; a red, about an hour.

Three-fourths of the heavens can be reached from Palomar with high accuracy; an additional ten percent can be covered in some degree. A supplementary survey of the remainder will be made after the four-year study is completed. The Palomar survey will record some five hundred million stars and perhaps ten million complete stellar systems of extragalactic nebulae. The resultant sky atlas, equivalent in size to 20 large volumes, will comprise reproductions of more than 2,000 overlapping plates.

The Schmidt telescope, invented in 1930 by Bernhard Schmidt, was the most significant advance in astronomical instruments for several decades. Parabolic reflectors like the 200-inch at Palomar have a very small field—only a fraction of a degree—and of that small field only a small area in the center is well defined. Schmidt discovered how to get sharp definition at low focal ratios. He did this by interposing at the center of curvature of a spherical mirror a thin correcting plate, deformed so as to parabolize the sphere, so to speak. By this means, light rays, first refracted by the correcting lens and then reflected from the mirror, focus uniformly on the photographic plate. For speed and convenience the Schmidt camera serves as the miniature camera of astronomy.



—Photos by National Geographic Society

ROSETTE NEBULA. Enlarged section of a Schmidt photograph showing a portion of the Milky way in the constellation of monoceros.

EDWIN P. HUBBLE, Mt. Wilson astronomer, who will direct the “Big Schmidt” sky survey at Palomar Observatory in California.

Make Plans for—

National Education Association, July 3–8, Boston, Massachusetts.

American Educational Research Association, July 4, Boston, Massachusetts.

American Veterinary Medical Association, July 11–14, Detroit, Michigan.

1st International Congress of Biochemistry, August 19–25, Cambridge, England.

4th International Conference of the International Association of Quaternary Research, August 22–September 15, Budapest, Hungary.

International Union for the Scientific Study of Population, August 27–September 3, Geneva.

British Association for the Advancement of Science, annual meeting, August 31–September 7, Newcastle-upon-Tyne, England.

15th International Conference of the International Union of Chemistry, September 6–10, Amsterdam, Holland.

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[1] The Society for the Study of Evolution and the ecologists will meet principally on the Columbia University campus where also the geneticists, parasitologists, and zoologists will have demonstrations.

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